IDEAS TECHNOLOGY DESIGN BUSINESS

WIRED

UK EDITION

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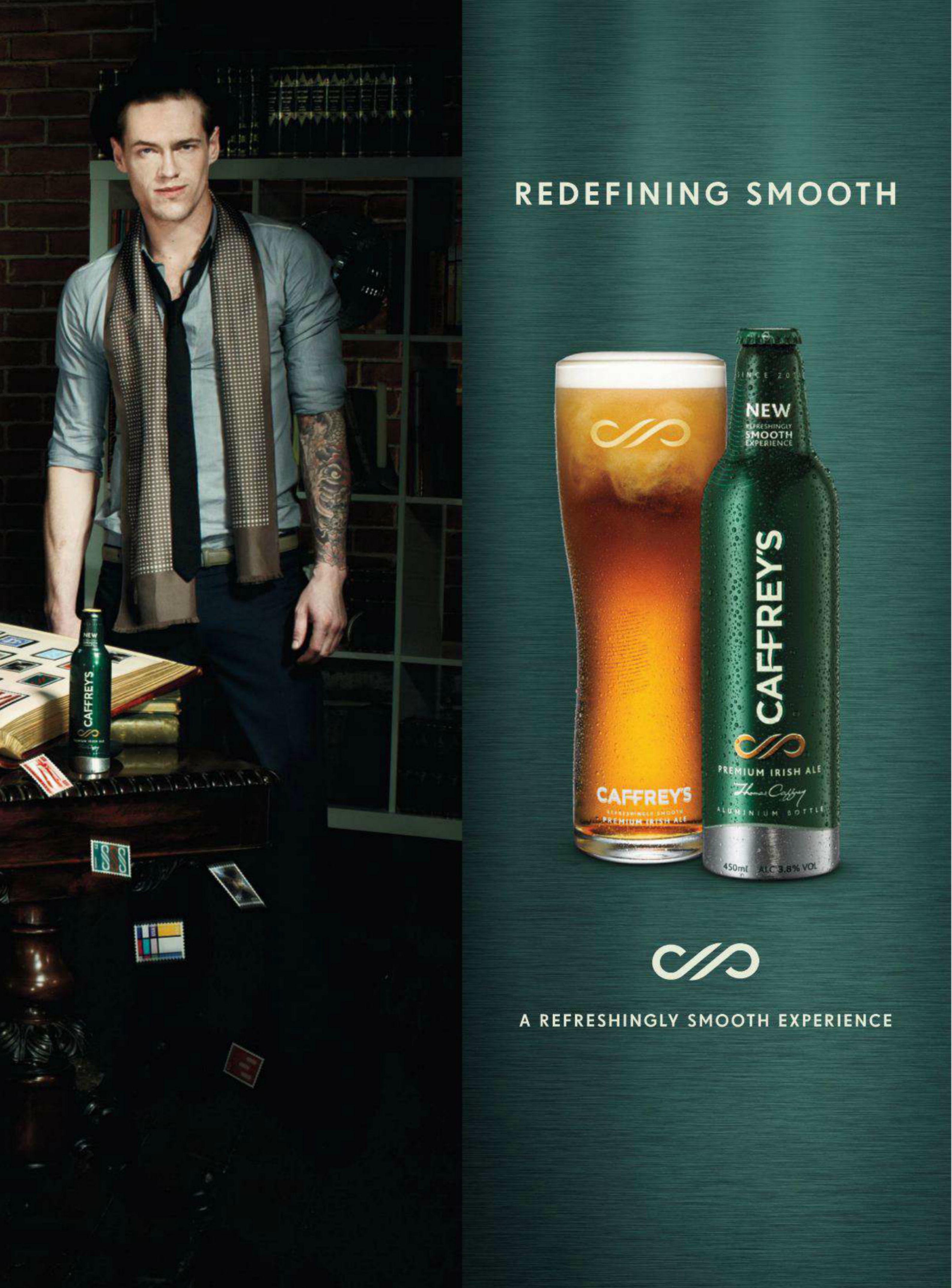
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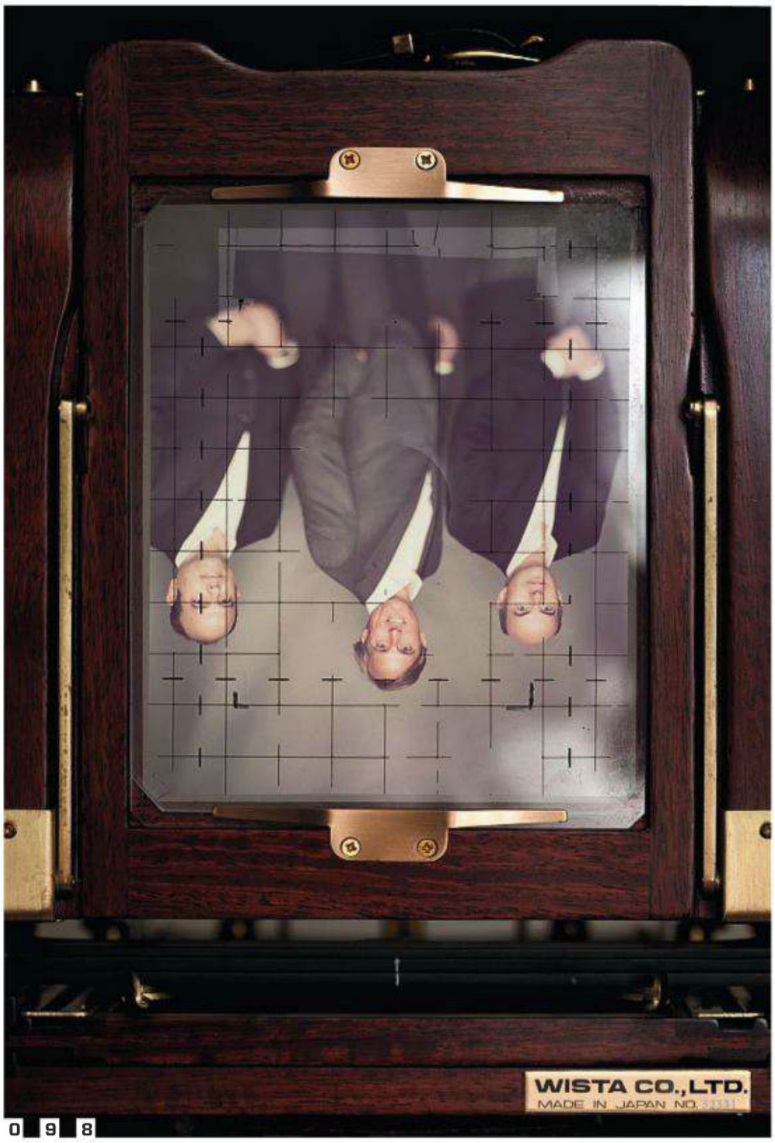

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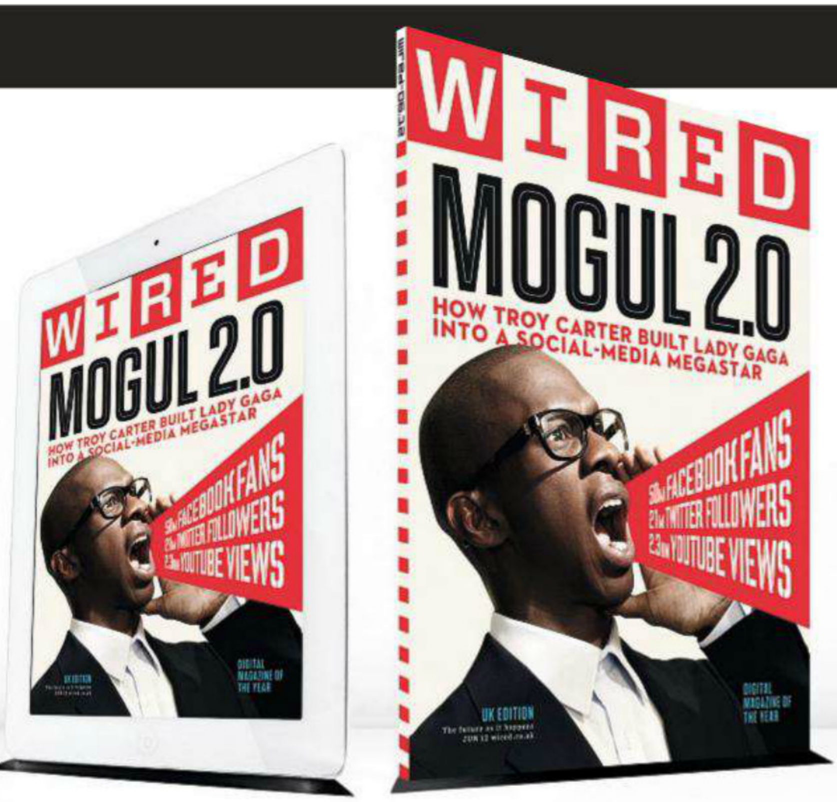
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DIGITAL MAGAZINE OF THE YEAR

06.12 Troy Carter: Mogul 2.0. Lady Gaga's manager taught us a thing or two about the vital role social media plays in transforming a pop star into a global force. Impressive, but not for the WIRED production desk – her online stats are rising so fast that our cover lines were in danger of being out of date by the time we went to press... **Contact us: rants@wired.co.uk**

WIRED TWEETS

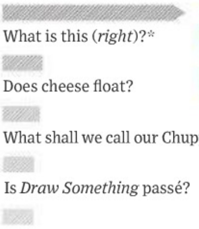
Hang on, *@WiredUK* – salt + vinegar = Hydrochloric acid (How To, 06.12)? And I've been putting this on chips and then *in my mouth*? *@mdgreaney*

Nice piece in *@WiredUK* on tickling trout. *Withnail & I* shotgun method is more productive though. *@thehippohouse*

***@WiredUK*, good to see my "smug pic" tweet in 06.12 mag. Then I saw that you had credited it to someone else! Any chance of a correction?** *@andyLapham*

READER FEEDBACK

WIRED posts generating the most comments on our Facebook page:



What is this (*right*)?*

Does cheese float?

What shall we call our Chuppi night light?

Is *Draw Something* passé?

Who's going to be investing in a VPN?

WE'RE WRITING THE SOCIAL MAP

I couldn't agree with Andrew Keen more that the evolution of social has not made us better people (Society isn't a startup and sharing's not caring, Ideas Bank 06.12). But I think the reality is far more positive than the picture you paint of this "new" way of doing what we essentially already do – attempt to build our own rich world up around ourselves. I know it's a question you ask in this article, but would you hazard a guess at where we're really going? I think the most exciting thing about social media is the fact that we really don't know where we're going. It involves risk and it can be incredibly powerful and rewarding. I hope his book makes more realistic and less apocalyptic (for the sake of controversy?) predictions. *Gumbopieman, via wired.co.uk*

TIME FOR CHANGE

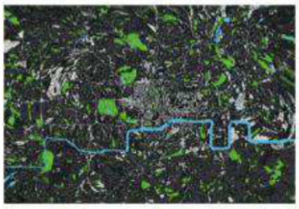
Got my subs copy with a very attractive-looking supplement on some very fine watches and watchmaking. But why is there only one model for ladies? As a female reader, I have never felt left ignored by your content – until today. Don't you want to appeal to your female readers? WIRED, you've disappointed me, I expected better of you. ***Jackie Hewitt, via email***

PLATFORM ALTERATION

Thank goodness that somebody else is tired of the love affair that WIRED has with Apple (Rants, 06.12). Stop spoiling an otherwise excellent magazine with this nonsense and give other platforms a chance. Some people don't follow the Apple ideal, nor want to! ***Tony B, via email***

LONDON'S ARTERIES

The map (London as seen from the Tube, 05.12) reminds me of those "your body the way your nervous system sees it" pictures, with huge fingertips, lips and tongue. Central London has more than its share of pain receptors... er...Tube stations. ***ixmal supermarine, via wired.co.uk***



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Sebastian Seung

A professor of computational neuroscience at MIT, Seung has some radical new theories about how our brains are wired up – and how this in turn creates who we are. Understanding the connectome, as he calls it, could explain disorders such as schizophrenia and depression – and perhaps let us upload our brains into a computer.

Claudia Hammond

Hammond writes in this month's Ideas Bank that we constantly alter our memories to recreate certain scenes. But does this mean we shouldn't trust our recollections? "It does, but they still feel concrete," says the London-based broadcaster. "If I compare childhood memories with my family's, we all remember something differently."

João Medeiros

With the Olympics just around the corner, our Start editor investigates how Britain's elite athletes are using high-tech performance analysis to improve the chances of winning. "There is a common assumption that coaches and athletes are technology averse," he says, "but the reality is that they are actually early adopters."

Joe McGorty

Our photographer for this year's WIRED 100 chose to go old-school by shooting our breakout nominees with a large-format analogue film camera. "I wanted to inject a bit of craft and traditional style to contrast with the high-tech visionaries," explains McGorty. "You end up taking a shot that's both intimate and analytical."

Elizabeth Hoff

Hoff photographed model and actress Lily Cole, who usually has her picture taken in the name of fashion. Here it was to highlight her social-network startup, which encourages neighbourly co-operation. "The shot is about Lily's new vision for money – and perhaps how we overvalue it," says Hoff. "I love the idea of helping our neighbours – I'm good at baking cakes."

PHOTOGRAPHY: NATE LANXON; IAN SKELTON

Making WIRED

Shooting the WIRED 100

Joe McGorty, "The 2012 WIRED 100", p98: "I think my favourite subject was e-crime specialist Charlie McMurdie (*lower left in frame*): bolt upright, hands behind her back, chin slightly raised – strong and authoritative police-officer-style. The Index Ventures team shot was fun – but tricky to do using an old camera."

Making the big list

David Rowan, "The 2012 WIRED 100", p98. "My office wall this month became a real-life Excel spreadsheet – with every vote and comment on the WIRED 100 nominations collated and then put in the right order. But here's the secret that we've never told anyone: the names on my wall were held there by nothing more than tiny chunks of Blu-Tack. How tenuous is power."

Flashing the cash

Elizabeth Hoff, "Pay it forward", p35. "Getting the 'money shot' was more literal than on any shoot I've done before. Watching a £50 note having hearts cut into it definitely appeals to the anarchist in me. I'm all up for swapping my photo skills for things other than money. Bring on the alternative economy. The world is changing so fast – you have be open to what it throws at you."

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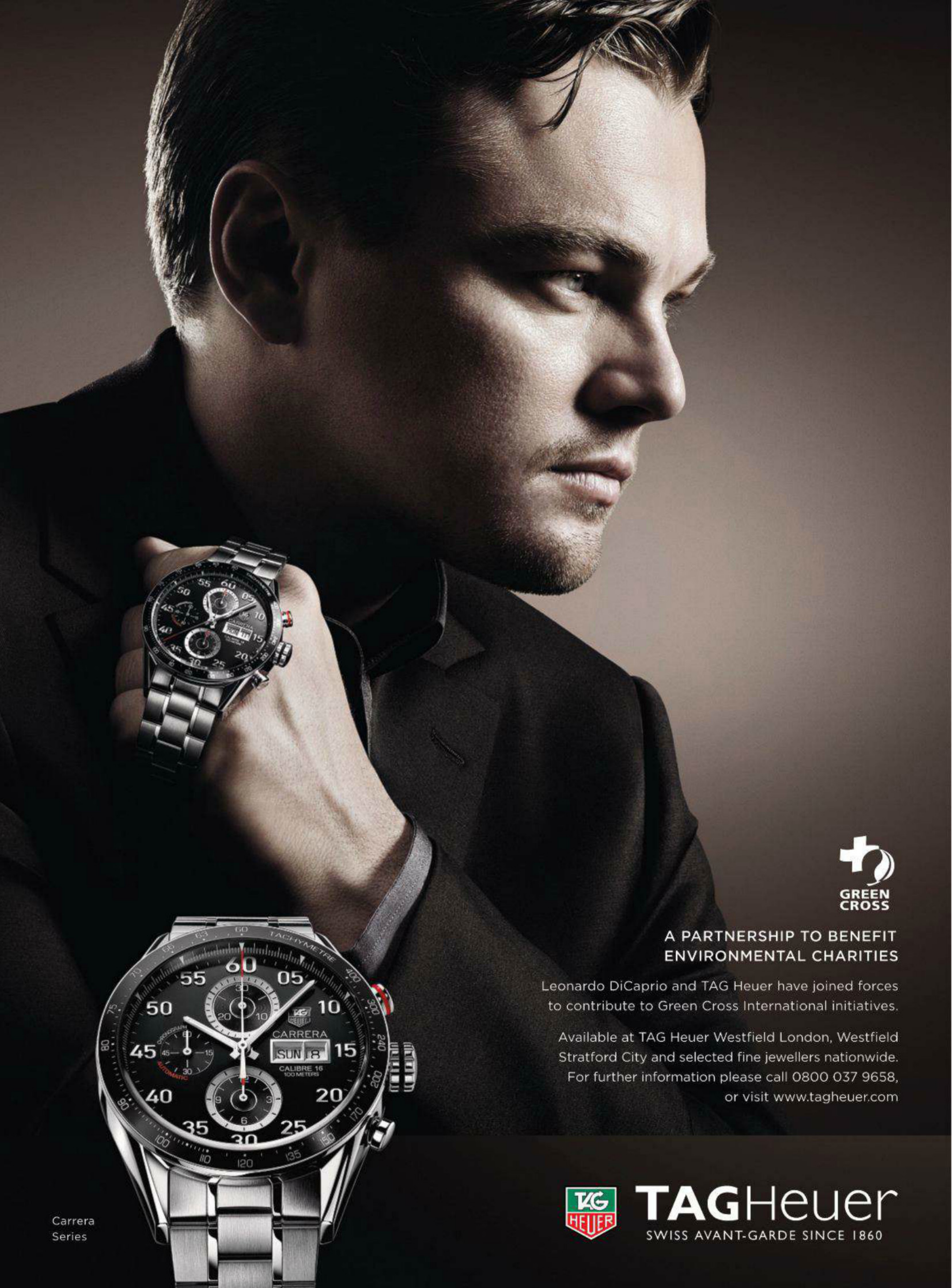

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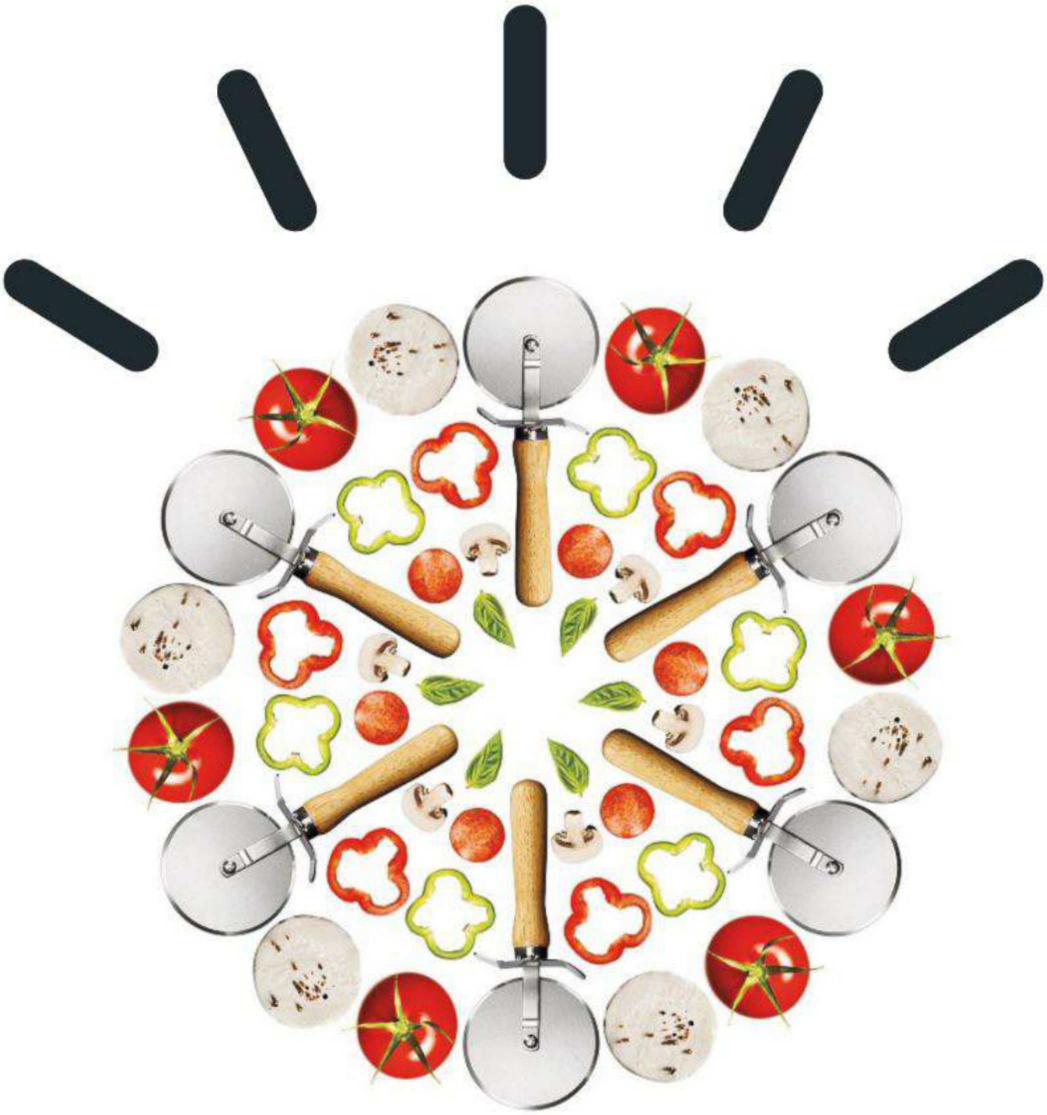

How a midsize restaurant group is earning a bigger piece of the pie.

On a smarter planet, midsize businesses need analytics to better serve their customers, operate more efficiently and encourage growth. Papa Gino's Inc., the Boston-based pizza and sandwich chain with about 150 corporate employees, was sitting on a gold mine of untapped sales, marketing and operational data. However, they needed a better way to leverage all this powerful data to make better decisions for their company. Working with IBM® and Business Partner QueBIT, they deployed a business analytics solution based on IBM Cognos® software that quickly transformed their data into actionable business insights. Analytics helped them discover that reward members visit their restaurants 35% more frequently and spend 50% more on online transactions. With new insights into the impact of their loyalty program, they can develop offers based on purchase patterns to increase the size of orders and purchase frequency. To see how IBM and our Business Partners can help your midsize business work smarter, visit **ibm.com**/engines/uk/pizza. Let's build a smarter planet.

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FROM THE EDITOR

Welcome to the third annual WIRED 100 issue, in which we list the most influential figures in Britain's digital economy. With the help of the WIRED community, we've named the decision-makers, entrepreneurs, designers and venture capitalists with the power to touch the rest of us – a snapshot of those who define the WIRED world.

We believe in science at WIRED – and yet we knew this could never be a scientific survey. So we've tapped into a wide range of informed views. First, we approached every member of last year's list and sought nominations for 2012: we asked them (anonymously) to name up to ten newcomers, ten who should leave the list, ten who should be higher, and ten lower. We asked the WIRED readership through wired.co.uk for must-have names; and our team sourced views among their own professional networks. We collated the data in as objective a manner as we could. From our longlist we prioritised names with multiple nominations. We excluded anyone employed by WIRED or Condé Nast, to avoid conflict. And everyone on the final 100 needed a strong UK link, if not a base here.

This year's list marks some major shifts in power. Michael Lynch's £7.1bn sale of Autonomy makes him Britain's most successful software entrepreneur; the growth of startups such as Mind Candy and Spotify have also shifted the balance of influence. You'll see some unexpected new entries, including gatekeepers to CEOs and ultraconnected event organisers – and the loss of such prominent 2011 names as James Murdoch and Julian Assange. How fleeting influence can be.

We're inviting the whole WIRED 100 as our guests to WIRED's own conference, WIRED2012, in London in October (wiredevent.co.uk) – two days of world-class speakers and networking opportunities. You're bound to have your own views on who should be where on the list – and who we missed out. So join the debate at wired.co.uk/2012wired100 or email us at rants@wired.co.uk.

Right: science played a key role in squash player Nick Matthew becoming a world champion

WIRED's Start editor João Medeiros also happens to be a theoretical physicist – with a PhD from Imperial College which involved modifying Einstein's theory of relativity. So João was the obvious choice to report on how science is helping athletes win medals. "I was apprehensive about how insightful athletes could be," he says. "But I got detailed scientific responses. It made me realise that athletes have an amazing understanding of what they have to do to become even better."

David Rowan, Editor

David Rowan

- D&AD Award: Covers 2012
- DMA Editor of the Year 2011
- DMA Magazine of the Year 2011
- DMA Technology Magazine of the Year 2011
- BSME Art Director of the Year, Consumer 2011
- D&AD Award: Entire Magazine 2011
- D&AD Award: Cover 2010
- Maggies Technology Cover 2010
- PPA Designer of the Year, Consumer 2010
- BSME Launch of the Year 2009

THIS MONTH ON THE iPAD EDITION

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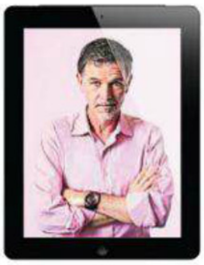
Paperobean has produced a range of do-it-yourself model kits. Download the app to view their card-based creations.



Netflix cofounder Reed Hastings visited WIRED's office for a chat. You can hear him on our iPad edition.

Memo Akten and Davide Quayola's *Forms* look great on the page, but the pair's animations come alive on the iPad.

PHOTOGRAPHY: FRED MACGREGOR; VICTORIA LING; SCOTT GRUMMETT

Upon arriving as a youngster in the U.S. with just a few dollars in his pocket, Thom Richard had just one dream: to fly aircraft. A seasoned pilot who has clocked up more than 9,000 flight hours, he now lives his passion to the full – in particular by taking part in the famous Reno competitions at the controls of *Precious Metal*, the most legendary of all race planes. His next challenge is to set the world speed record and to win Reno. On his wrist is the Chronomat, an ultra-sturdy and ultra-reliable instrument powered by a high-performance "engine", a 100% Breitling movement. For Thom Richard, it is quite simply the world's best chronograph.

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START

NEWS AND OBSESSIONS

THIS MONTH: 07.12

- LEGO AS LAB ASSISTANT
- LILY COLE'S SOCIAL NETWORK
- WORDS IN WAITING
- THE 10CM^3 SATELLITE
- GLOBAL GROUNDWATER

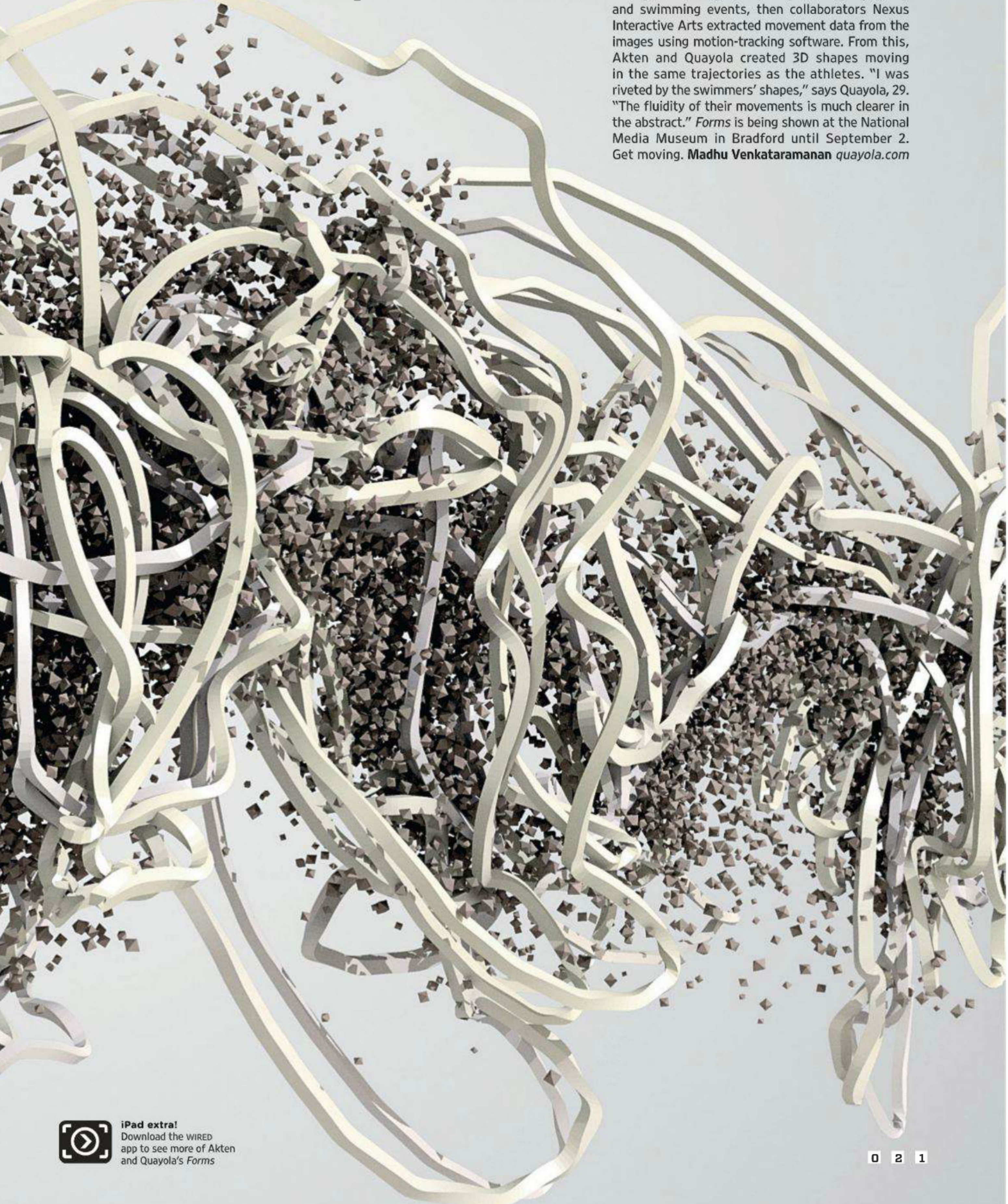
EDITED BY JOÃO MEDEIROS

CREDIT TO GO IN HERE

Abstract Olympics

Revealing athletics' inner beauty through motion-tracked artwork

As part of the London 2012 Cultural Olympiad, London-based artists Memo Akten and Davide Quayola (WIRED 05.12) have been turning athletic movement into animated shapes. For the project, entitled *Forms*, the pair collated archived Commonwealth Games footage of floor gymnastics (*pictured*), high jump and swimming events, then collaborators Nexus Interactive Arts extracted movement data from the images using motion-tracking software. From this, Akten and Quayola created 3D shapes moving in the same trajectories as the athletes. "I was riveted by the swimmers' shapes," says Quayola, 29. "The fluidity of their movements is much clearer in the abstract." *Forms* is being shown at the National Media Museum in Bradford until September 2. Get moving. **Madhu Venkataramanan** *quayola.com*



iPad extra!
Download the WIRED app to see more of Akten and Quayola's *Forms*

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'Entrepreneurship is an act of stupidity'

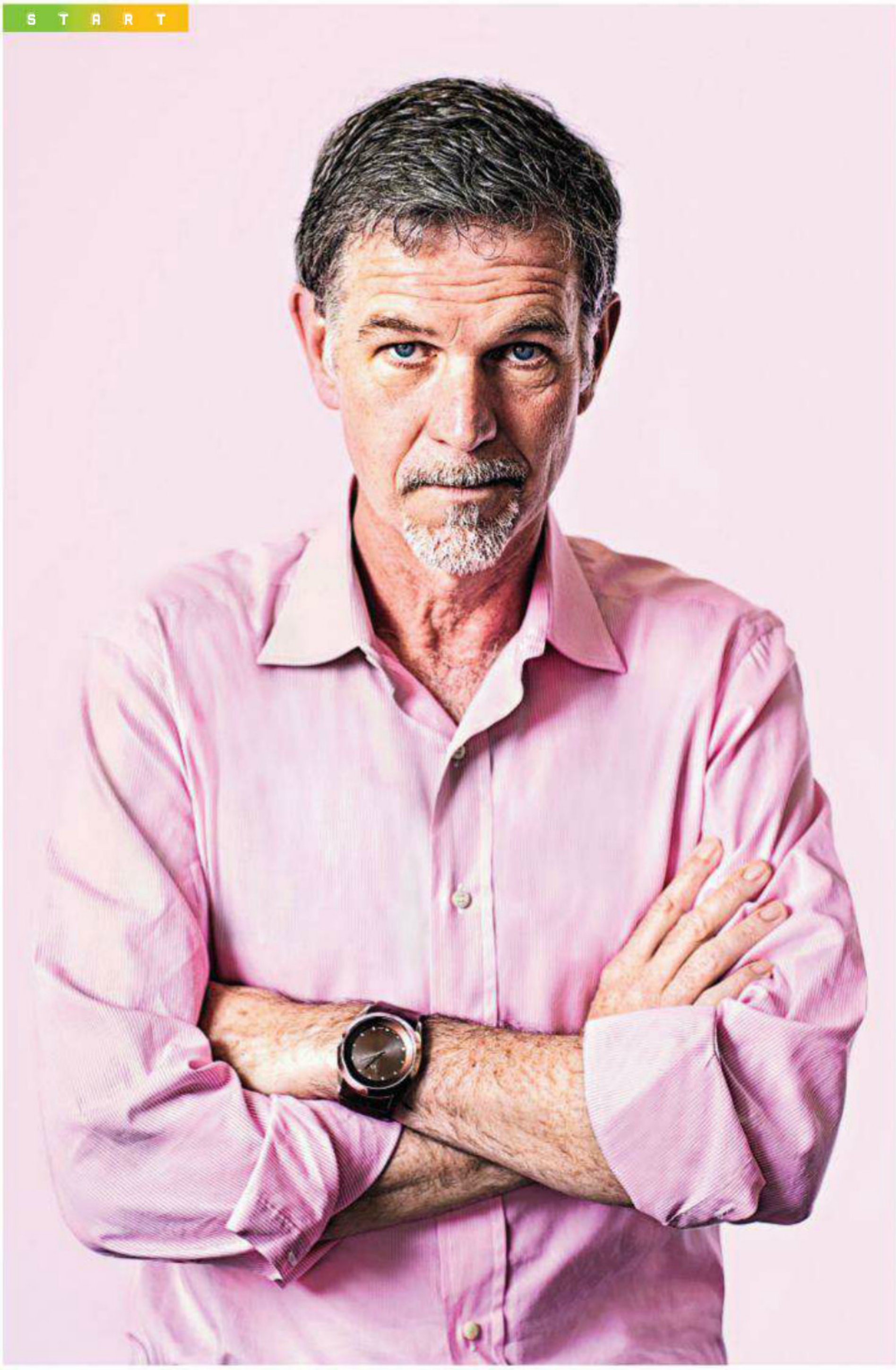
Netflix's CEO on home entertainment – and Facebook's crazy idea

Reed Hastings is one of Silicon Valley's power brokers – not just as CEO of Netflix, the video-streaming service, but through his board seats at Facebook, Microsoft and the Startup America Partnership. Netflix has grown to 47 countries, including the UK, since he founded the firm in 1997. Hastings, 51, recently stopped by WIRED's London office to discuss what's next.

Looking back 15 years, would you have done anything differently? We would have started later. When we launched there were hardly any DVD players, so the first couple of years we just struggled. But as an entrepreneur you have to feel like you can jump out of an aeroplane because you're confident that you'll catch a bird flying by. It's an act of stupidity, and most entrepreneurs go splat because the bird doesn't come by, but a few times it does. Most entrepreneurial ideas will sound crazy, stupid and uneconomic, and then they'll turn out to be right. I'm on the Facebook board now. Little did they know that I thought Facebook was really stupid when I first heard about it back in 2005. I thought, "Who would want to put their face on a website?"

What will be the next big disruption in entertainment? Disruptors always look for an underlying change that they can take advantage of. In this case, it's fibre optic. Now, high-speed video links mean we have more options to create global video services. Fibre optic is becoming like electricity. If you look at how electricity spread around the globe 100 years ago, that's what's happening now.

How will we be consuming media in ten years' time? The next wave will be various kinds of pervasive computing where you've got wristbands, goggles and other devices that animate your experience. People will look back on our computer screen and keyboard and it will seem very archaic, like DOS might seem to us today. As that wave of pervasive and wearable computing grows, there will be whole new entertainment scenarios enabled by that technology. **JM**



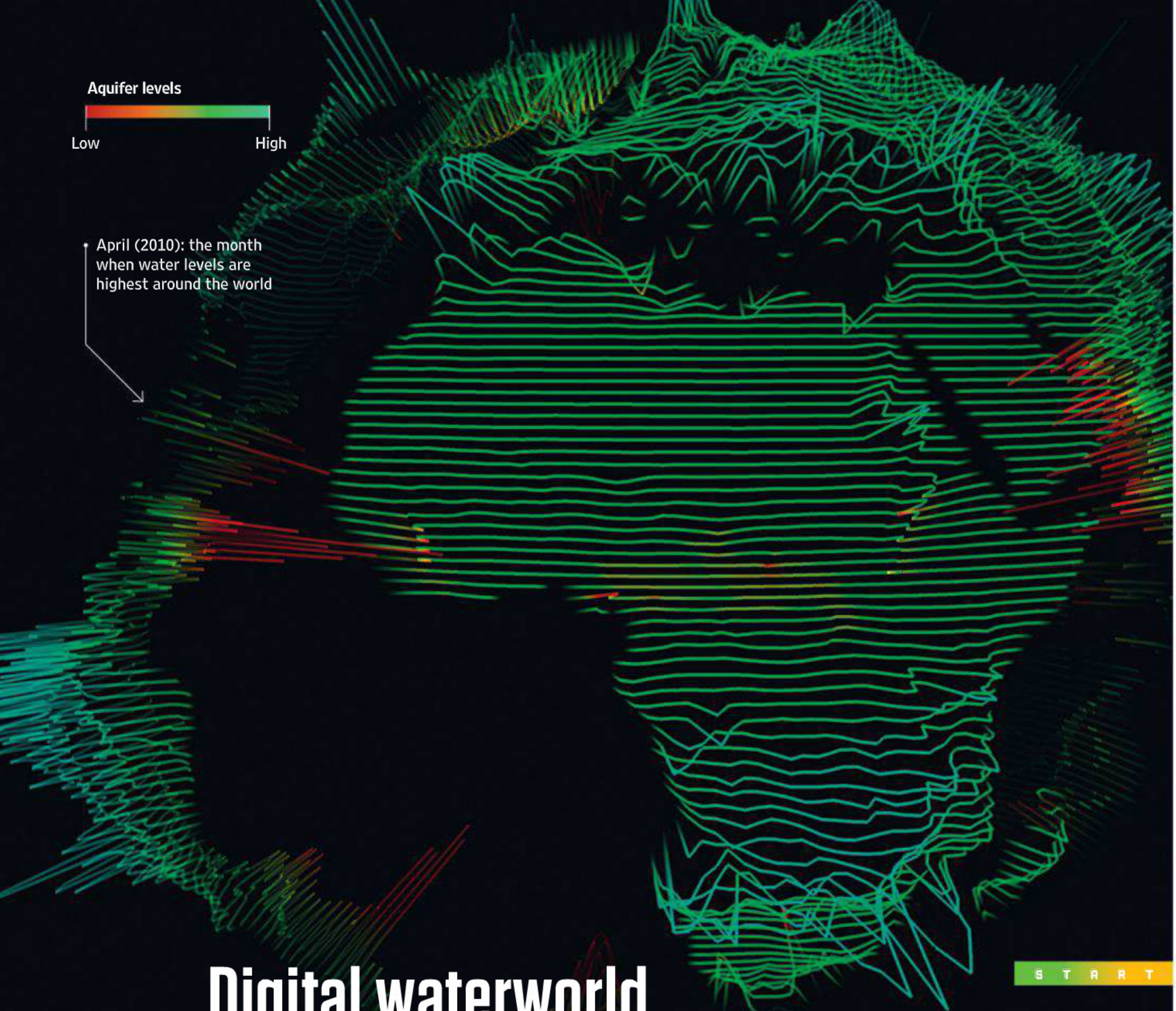
PHOTOGRAPHY: SCOTT GRUMMETT, IN WIRED'S LONDON OFFICE

THE WIRED INDEX

2.57 QUADRILLION
Calculations performed per second by China's fastest supercomputer, as rated by the TOP500 project

10 QUADRILLION
Calculations performed per second by Japan's fastest supercomputer, as rated by the TOP500 project

For sources, see Colophon (p158)


Aquifer levels
Low
High
April (2010): the month when water levels are highest around the world

Digital waterworld

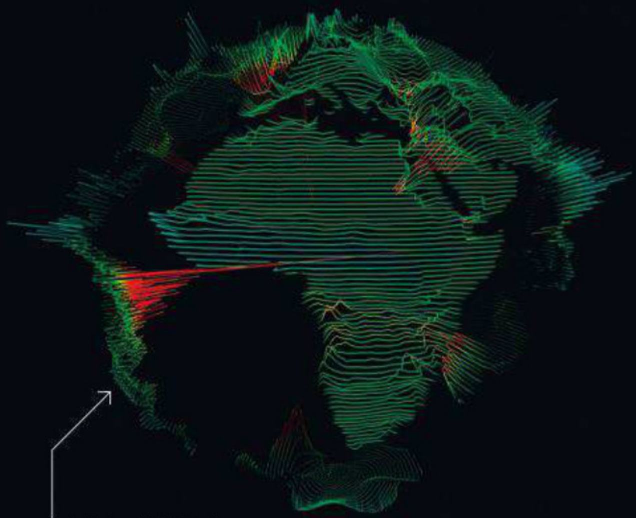
And now for the underground surf report, with a little help from a pair of Nasa satellites

Around 30 per cent of Earth's fresh water, a total of 23,400,000 km^3, ebbs and flows below the planet's surface in rivers and reservoirs. This image, by Jay Weeks, a Los Angeles-based designer, shows how these groundwater levels fluctuate underneath our planet over time. To create the interactive visualisation, Weeks used 64,800 publicly available data points from Nasa's twin-satellite Gravity Recovery and Climate Experiment. These satellites, launched in March 2002, map variations in the Earth's gravitational field, caused in part by the movement of the planet's water.

The visualisation, which maps the distribution of groundwater against the long-term average for each area, shows seasonal variations. During wet seasons and winters, more water flows into aquifers, then the level diminishes as water resurfaces through streams and springs, unless replenished by more rain. The wettest month of the year is April, when the global average rises by 21.8mm thanks to the rainy season in the Amazon and elsewhere in the southern hemisphere. In October, Earth's driest month, drought across sub-Saharan Africa and South America pushes the global average 18.1mm below average.

"This project serves as proof of the potential of public data," says Weeks, 24. OK, but why does the UK still have a hosepipe ban? **Dan Smith** *waterunderground.info*

iPad extra! Download the WIRED app to interact with Weeks's infographic


October (2010): the month when global water levels are lowest

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The satellite I made myself

Song Hojun plans to send this box into orbit – financed by selling t-shirts

On August 31, Korean artist Song Hojun plans to launch a tiny satellite from the Baikonur Cosmodrome in Kazakhstan. The 10cm^3 shiny metal cube has as its payload four bright white LEDs that can be seen from Earth. Once it is in orbit – at an inclination of 64.9°, if all goes well – anyone with a standard radio transmitter will be able to send it messages, which will be flashed back to Earth in Morse code.

Rather than rely on a team of specialists, Song, 33, has designed and built the satellite himself. "I wanted everything to be built by hand, not computer-machined, to show that anyone can build a satellite," he says. "Scientifically, it is useless – it's like a Sputnik. The question is: which is more important, the art or the science? I am from an engineering background but I was wondering why you have to choose to become an engineer or to do something like literature, say. I don't like that choice."

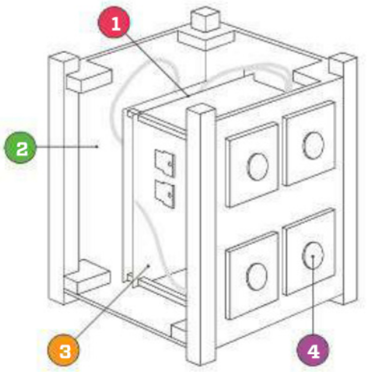
The satellite should remain in orbit for a year, and its message-sending slots will be assigned on a first-come-first-served basis. But you'll have to be careful you don't miss yours: "Due to power issues, the messages will be a once-a-day event, lasting 16 seconds," says Song. "It's sort of like a space tweet."

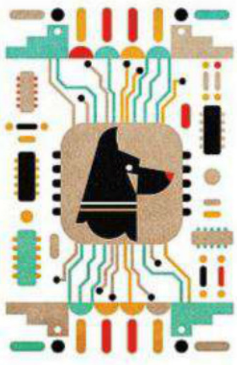
So far the satellite has cost him a fairly reasonable £630. But the astronomical cost is yet to come – actually launching it into space. The satellite will be hitching a ride on a Soyuz rocket launching a much bigger Russian biological research satellite, containing mice and geckos. To buy his tiny satellite a ticket on that ride, Song needs to raise $100,000. He has printed 10,000 T-shirts to sell at $10, but so far has sold only 200. "The project has been a total failure from a business point of view," he says.

What's more, the launch date is much earlier than he was expecting and finishing the satellite on time will be a challenge. "It is a big test," he says. "Is there enough time? It is almost devastating but I have to do it. I feel confident I will get the satellite finished, but I need to recruit someone to work on the T-shirts." Any volunteers? **David Baker** *opensat.cc*

WHAT'S INSIDE THE BOX?

1 ATmega168 Automotive Arduino board with watchdog timer
2 Lightweight, vibration-resistant aluminium 6061 alloy chassis
3 Battery powered by Spectrolab triangular advanced solar cells
4 Four high-powered white LEDs





SNIFFING OUT TROUBLE IS AS CHEAP AS (MICRO)CHIPS

Can a microchip do everything a sniffer dog can? Cambridge-based Owlstone Nanotech thinks so. It has developed a sensor that detects almost any chemical, even in very low concentrations. The devices measure 7.5mm by 7.5mm and cost only £3 each to make. Applications include dropping them into war zones to identify improvised explosive devices by their tell-tale chemical signatures, before troops go in.

The idea came after 9/11: "There was a big drive for better explosive-detection systems," says Billy Boyle, who cofounded the company in 2001 while still a nanotech researcher at Cambridge University. "Existing techniques were bulky, expensive and didn't perform well."

The new system is a silicon chip with two layers and an ionisation source. A detector filters the target molecules and identifies them by how quickly they move through an electrical field. The system can be programmed to detect almost any threat – airborne or dissolved.

Next up are medical diagnostics. "The chips can be integrated into a device that detects chemicals on the breath that signify disease," says Boyle. "We're very excited." **Daniel Cossins** *owlstonenanotech.com*

PHOTOGRAPHY: STEVE SCHOFIELD. ILLUSTRATION: PARKO POLO

Science is Fantasy.

SCREENED
ASSISTANT APPS

WIRED

Siri
The new standard for iOS, voiced in the UK by *The Weakest Link*'s Jon Briggs. Just don't ask it too many existential questions – particularly who its parents are. *iOS, Free apple.com*

Iris
No iPhone? No problem. *Iris* brings to Android what *Siri* brings to iOS. Not perfect, but it'll do until Google develops its own part-sentient alternative. *Android, Free dexetra.com*

Speaktoit Assistant
A customisable cartoon character that takes your natural-language questions and helpfully pulls up relevant results from the web. *iOS, 69p; Android, Free speaktoit.com*

Evi
The most *Siri*-like of the non-*Siris*, *Evi* can give in-app answers to your natural-language questions – but it can't manage your contacts or alarms. *iOS, 69p; Android, Free evi.com*

Vlingo
"Update Facebook status, I'm reading an awesome issue of WIRED!" *Vlingo* turns such voice commands into hands-free actions. *Android/BlackBerry/Symbian, Free vlingo.com*

WEIRD

Voice Camera Pro
Yell "Shoot" to take a picture, "Flash" to toggle the flash, and so on. It might seem silly now, but just wait until Canon puts this feature in a future DSLR. *iOS, £1.99 apple.com* **Nate Lanxon**

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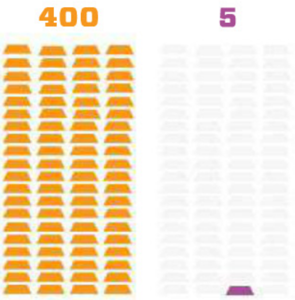


Grams of gold that can be mined from one tonne of mobile phones

Grams of gold that can be extracted from one tonne of gold ore

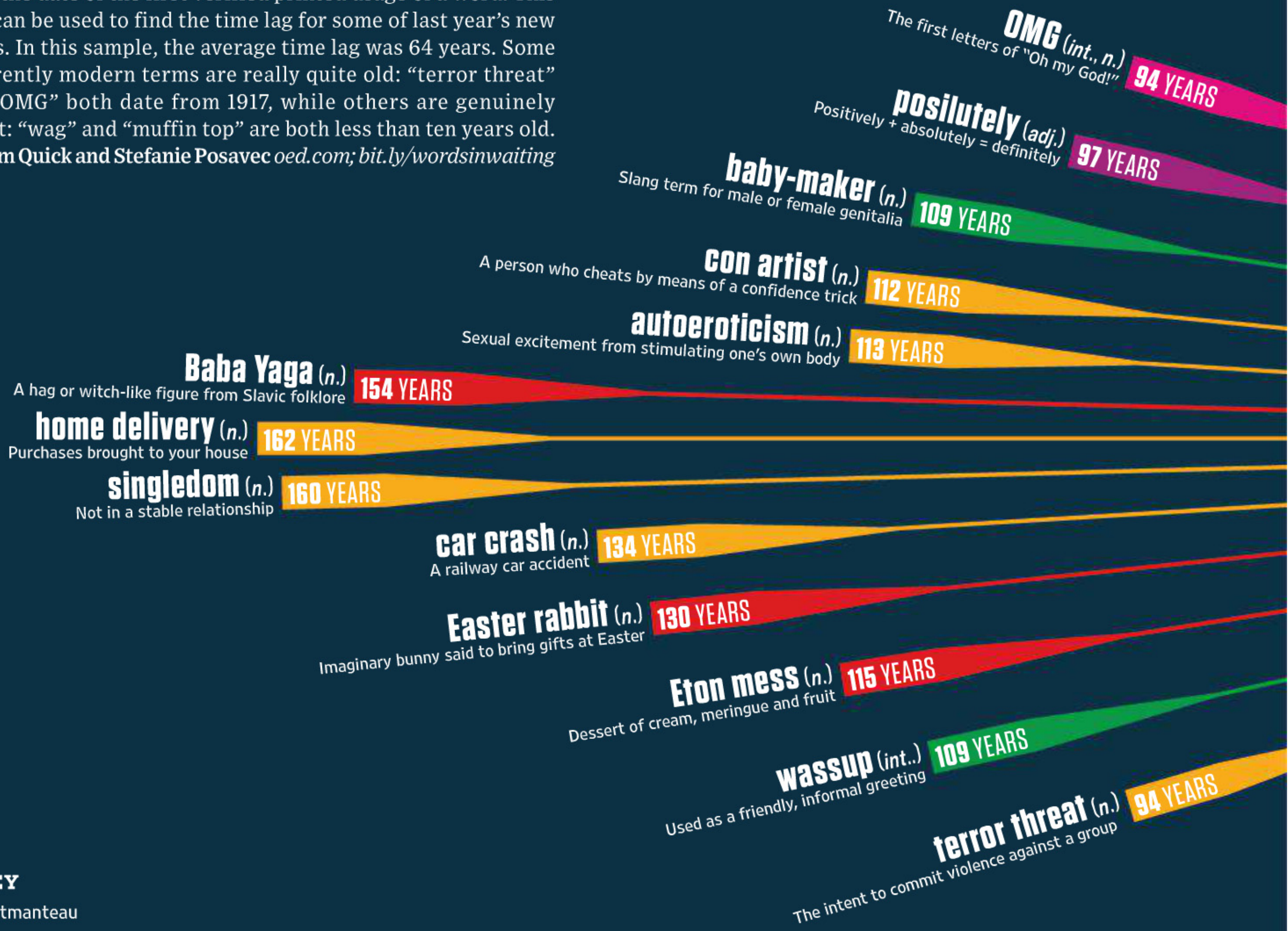
For sources, see Colophon (p158)

Words in waiting

From first use to dictionary entry can take a word or phrase a century or more

Being included in the *Oxford English Dictionary* is an English word's equivalent of a knighthood. But, as our infographic shows, a word can be around for a long time before it makes the cut.

The *OED* online is updated four times a year, and each entry gives the date of the first verified printed usage of a word. This data can be used to find the time lag for some of last year's new words. In this sample, the average time lag was 64 years. Some apparently modern terms are really quite old: "terror threat" and "OMG" both date from 1917, while others are genuinely recent: "wag" and "muffin top" are both less than ten years old. **Miriam Quick and Stefanie Posavec** *oed.com; bit.ly/wordsinwaiting*



KEY

- ● Portmanteau
- ● Acronym
- ● Name
- ● Neologism
- ● Science and technology
- ● Slang
- ● Foreign import

INFO PORN

The *OED* has shifted from a prescriptive to descriptive stance; from telling people which word to use to chronicling terms they use

THE BIG QUESTION

"What are the most interesting ideas and projects at the intersection of art and science today?"

David Eagleman
Neuroscientist and best-selling author

"When squeezed to the scale of human perception, science produces art. Consider fast- or slow-mo technologies: mushrooms shoot up and wobble into bloom or a photon saunters through a glass bottle, as viewed at a trillion frames per second."

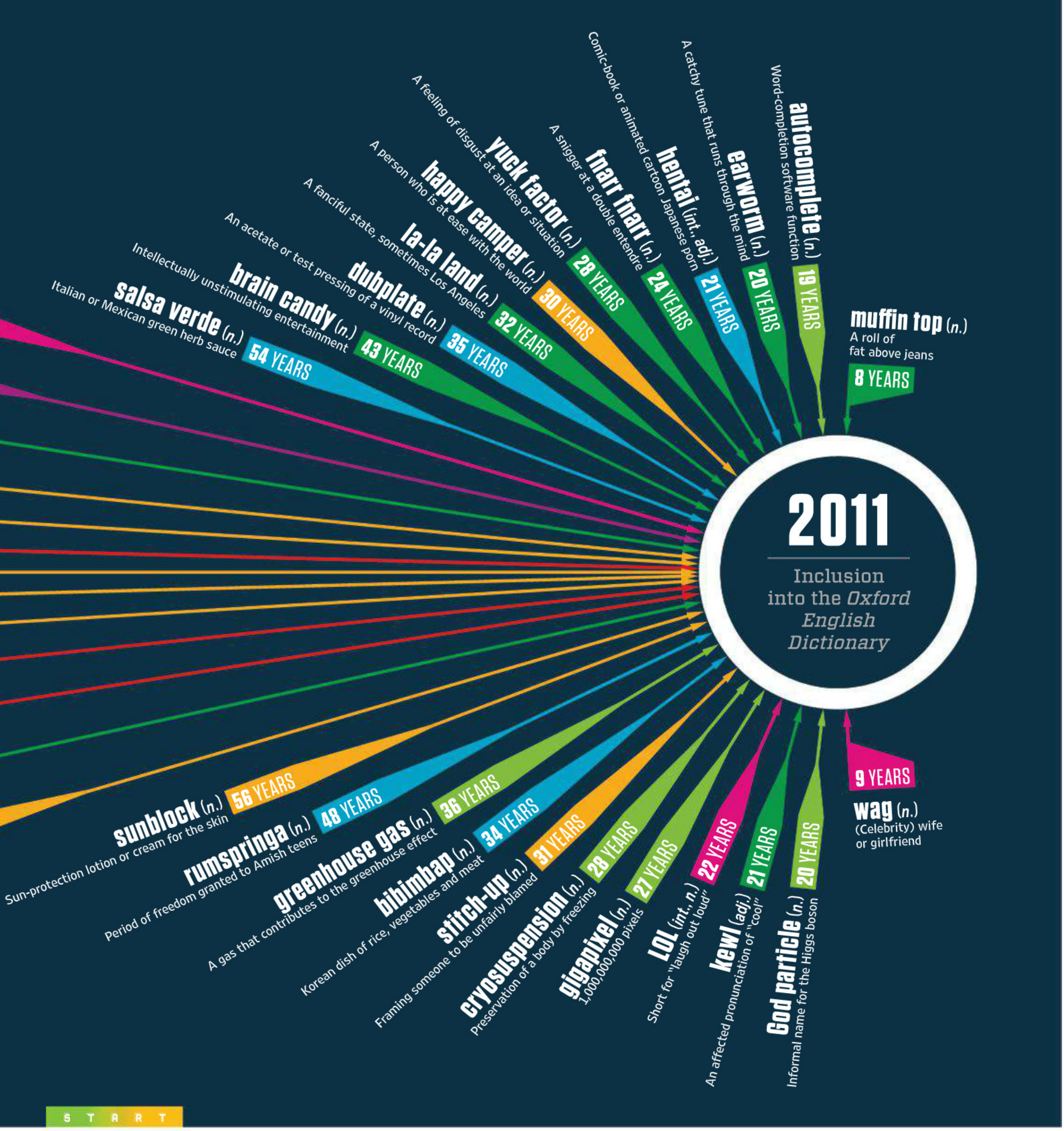
Suzanne Lee
Director of the BioCouture Research Project, London

"The open-source, DIYBio movement makes the once obscure accessible to all, facilitated by community labs like Genspace in New York, which offers biology courses. The surge in iGEM competition shows the future of design-led bioengineering."

Cynthia Pannucci
Director of Arts & Science Collaborations Inc, US

"Most exciting is that artists are creating ways to interpret the processes of research. Julian Voss-Andreae's *Quantum Man* sculpture visualises a theory; artist Victoria Vesna and scientist James Gimzewski describe technologies invisible to humans."

ILLUSTRATION: (DESIGN) STEFANIE POSAVEC; (RESEARCH) MIRIAM QUICK



Nicola Triscott
Director of London-based Arts Catalyst

"German artist Agnes Meyer-Brandis fuses research and fiction. Her work explored the zone below the earth and ice, but recently shifted to the skies. She is training a flock of Moon geese to fly to the Moon and is trying to affect meteor trajectories."

Susana Soares
Senior lecturer at London South Bank University

"Synthetic biology and genetics could redefine the body. Projects such as Material Beliefs, Impact and Synthetic Aesthetics are experimental collaborations between design and science that facilitate debate about the ethical dimensions of technologies."

Elizabeth Jameson
Freelance lecturer and neuroscientist artist

"Brain-imaging technologies have invited a new language of portraiture, expanding identity beyond external likeness. Through exploration of brain structures, my art conveys an aesthetic of selfhood that remodels what it means to be human."

Felice Frankel
Science photographer and research scientist, MIT

"A virtual community of graphical designers and scientists is in the works through visual-strategies.org. Designers, researchers and science students will create more compelling ways to express scientific concepts, and everyone will teach other." MV

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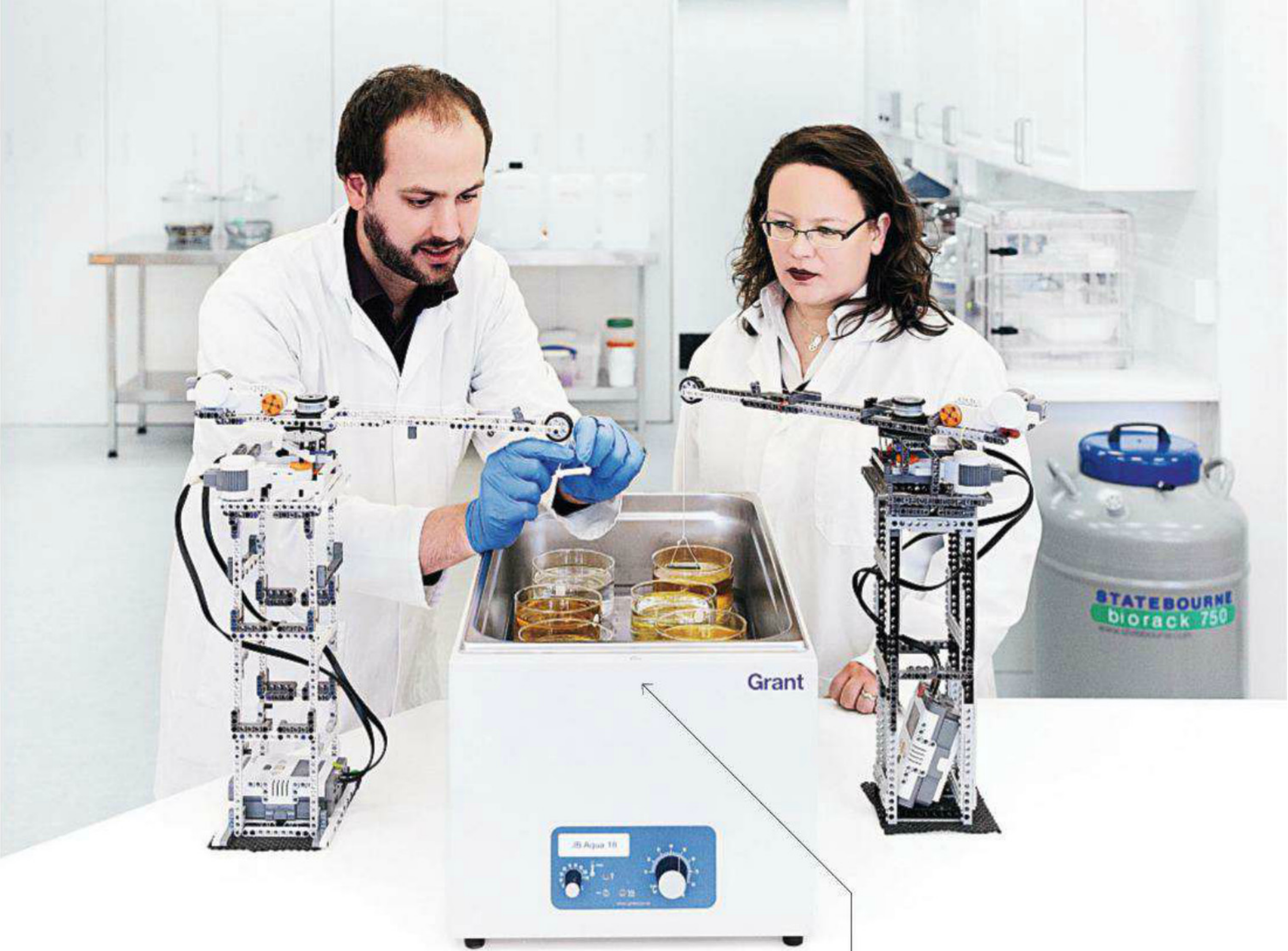

PHOTOGRAPHY: SUN LEE

Playful prototyping

A PhD student has found a cheap and reliable assistant for the tedious parts of his research: a Lego model kit

When he was working towards a masters degree at Cambridge, Daniel Strange had to spend hours dipping bits of metal into mineral and protein solutions to create a bone-like material. It was important work that could lead to advances in medical implants, but it was mind-numbingly boring. So he automated the process by turning to an unlikely source. "Lego has the whole package," says Strange (*above, left*), now a PhD student studying biomedical engineering under the supervision of Cambridge's Michelle Oyen (*right*). "It's got all the electronics, components, gears and motors that you need to build a prototype. And if a ten-year-old can use it, I hoped that I could."

Using a Lego Mindstorms NXT kit, Strange, 25, built and programmed a crane that moves in a set path, raising and lowering the sample between beakers containing solutions. The lab now has two of them working round the clock. "They're a bit wobbly but they do the job precisely," Strange says. The kit retails for around £300; a similar scientific instrument would cost thousands. "We use the kits for a bunch of projects. It's a very flexible platform."

The Lego cranes have already featured in the journal *Acta Biomaterialia* in a paper on the bone-like material they help produce. "We're trying to mimic the composition of bones. Our robots make that easier." **Daniel Cossins** *oyenlab.org*

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✝

Percentage of the world's Christians who lived in sub-Saharan Africa in 1912

✝✝✝✝✝✝✝✝
✝✝✝✝✝✝✝✝
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The same in 2012
For sources, see p158

Dunking with Lego: how to make bone-like material

1. Dip a metal core in calcium and protein.

2. Then in phosphate and protein. Repeat.

3. Break off the built-up layer for analysis.

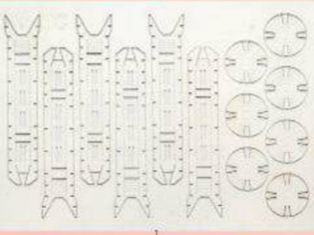
Paper plane 2.0

Try launching *this* during your next Tuesday-morning meeting

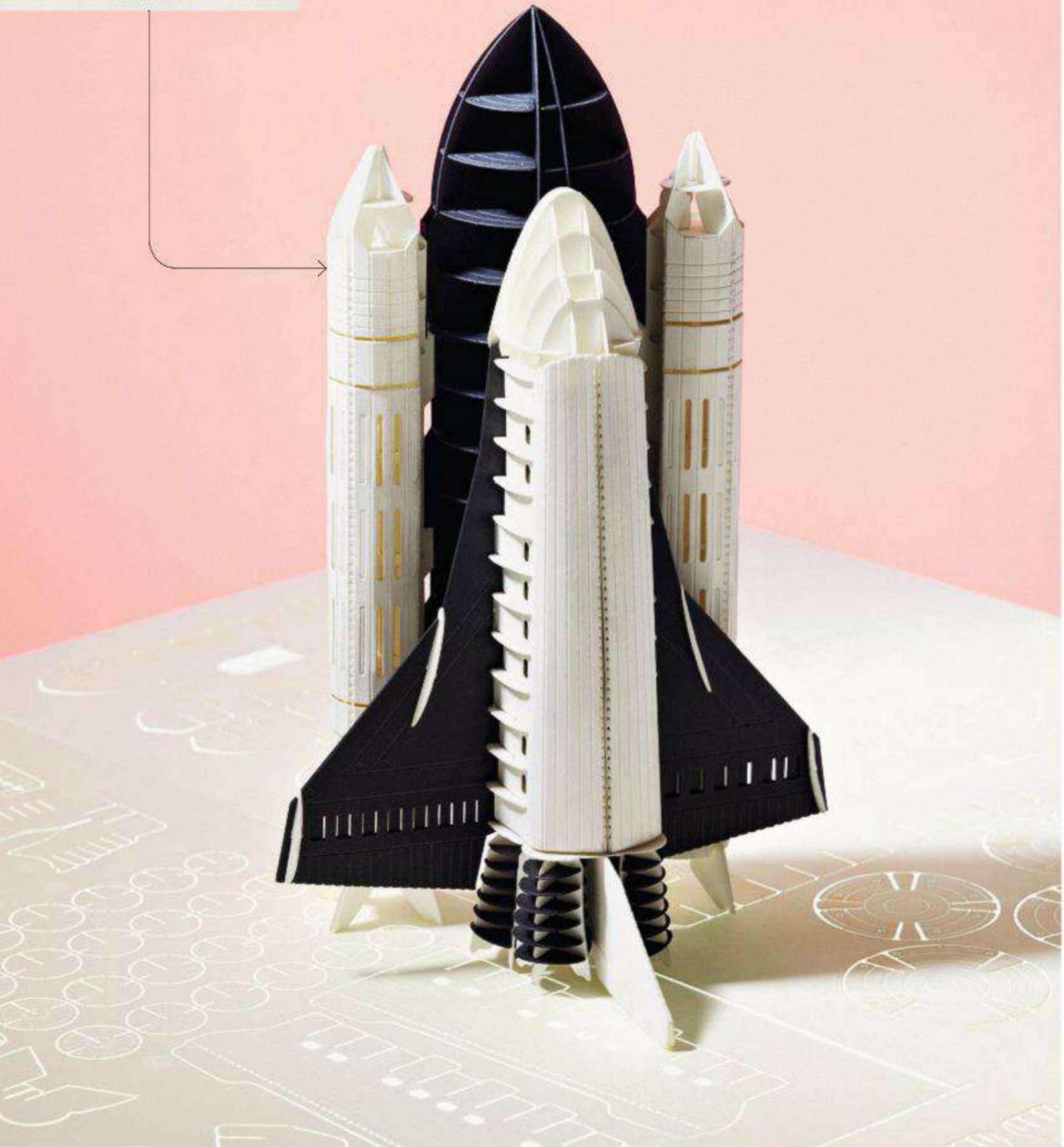
Never mind your folded A4 plane: here's the Papero Space Shuttle. This card model is one of several miniature machines you can craft yourself from pre-cut recycled paper. The range, produced by Paperobean, a design company based in Seoul, South Korea, also includes a motorcycle, a school bus, a train and a helicopter – with rotating blades.

"There are many paper products and miniature toys on the market but few have such exquisite details," says Kang-Kook Kim, head designer at Paperobean. "The product's aim is to give users both the pleasure of assembly and the visual delight of these exposed paper structures," he adds. "I like to describe it as a kidult toy – they can be built without scissors, knives or glue. To complete the products, users have to consider where each piece has to be placed in the overall design; for children it's a way to understand 3D structure." A bit like an Airfix model, then, only without the part where you glue your fingers together.

Epha3 Farm, an online platform to promote the work of designers around the world, will distribute the product in Europe. Paper-ball toss just got binned. **Daniel Cossins** *ipapero.com*



It's not rocket science: remove the Space Shuttle's pre-cut pieces and fit them together using tabs instead of glue



JARGON WATCH

Zombie debtor
n. An indebted consumer who is only able to pay off their debt interest every month. According to R3, the Association of Business Recovery Professionals, one in six of those in debt in the UK are zombie debtors. These are mostly payday loans, but 11 per cent are credit-card debts and nine per cent are bank overdrafts.

Tweetation
n. A tweet that includes a link to a scholarly article. This blend of "tweet" and "citation" comes under the rubric of *altmetrics*: tools that assess the impact of articles based on online measures such as bookmarking, linking and blogging. Traditional measures of impact are increasingly seen as too slow and narrow in the internet age.

Möbius strip journalism
n. Media coverage of a story in which the story is based on what reporters *believe* will be the media coverage of the story. The phrase was coined by media critic Jay Rosen, who sees it as a subset of *horse-race journalism*: reporting that focuses on poll results and political battles instead of policy issues. **Paul McFedries**

PHOTOGRAPHY: VICTORIA LING. ILLUSTRATION: ROBIN BOYDEN

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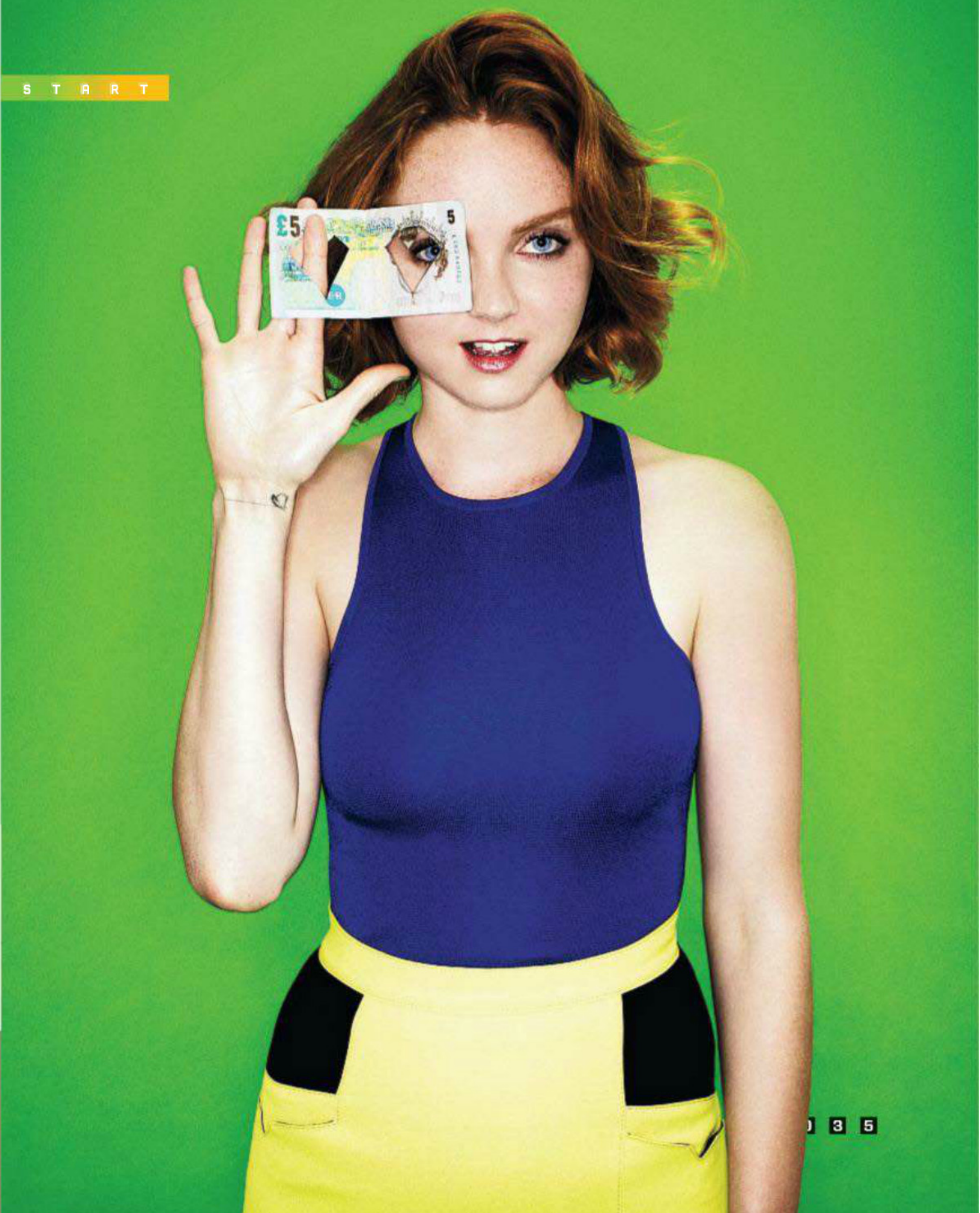
Pay it forward

Lily Cole wants you to lend a helping hand to your social-network neighbours

The average Londoner knows just one neighbour," says model and actress Lily Cole. "I travel a lot and I'm always surprised by the strong sense of community in some countries. We've lost something fundamentally human and we don't even realise it." During a trip to the Thai-Burmese border in 2010, Cole came up with an idea: a social network built around giving. "Social media is popular because it feeds into our desire to be connected," she says. "I want to transport that into real life, with real value."

Cole's social network, Impossible, has been designed for users to meet and help each other. Users post requests (say, "I wish to have a haircut"), and anyone in their local network can offer to help. The emphasis is on giving, rather than bartering. "Giving triggers social cohesion," says Cole, 24. "It's also the basis for an economy not based on money. Impossible will facilitate that via social media."

Impossible is in beta and is still self-funded, and its advisers include Wikipedia founder Jimmy Wales and economist Hazel Henderson. For Cambridge graduate Cole, this is an addition to a modelling and acting career (she's in *Snow White and the Huntsman*, in cinemas June 1). "Impossible is a utopian idea," she says, "but I do believe it is possible." **JM** *impossible.com*



WE KNEW YOU WERE GOING TO TYPE THAT

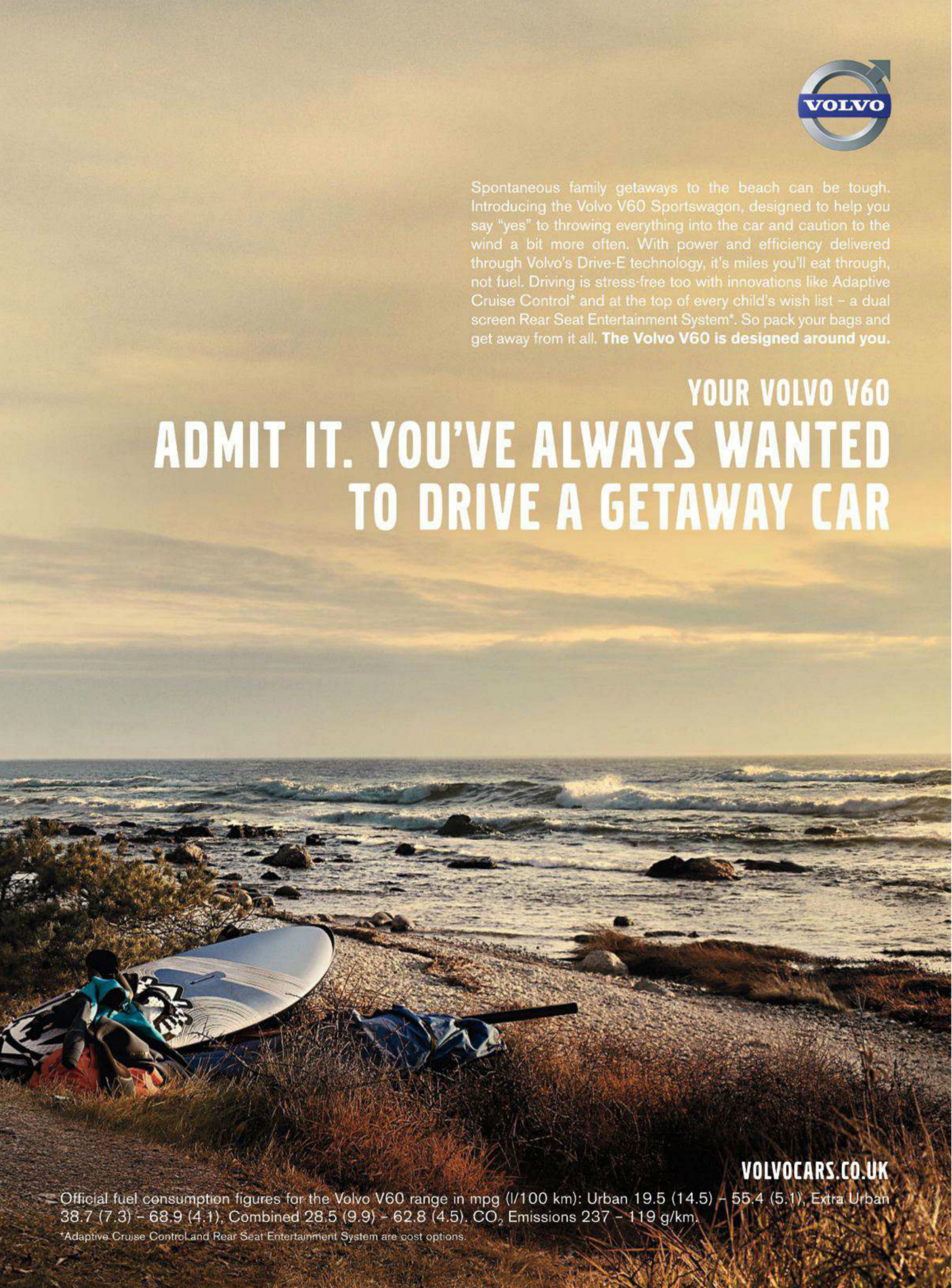
In early 2008, Jonathan Reynolds was working for the UK government on the financial restructuring of Eurostar, when he saw a lawyer using a QWERTY keyboard on a BlackBerry. "It struck me," he says, "that we were using something so outdated to input information on a piece of technology."

In July 2010, Reynolds launched *SwiftKey*, an app for Android devices that predicts what you are going to type next. This is no clumsy predictive text swapping out your swearwords – *SwiftKey* looks at the context of what you are writing and makes an informed guess. It learns your writing style from your emails, SMSs, tweets and Facebook updates and combines this with a trillion-word database of word pairs and triplets.

The company claims *SwiftKey* can make a correct prediction 50 per cent of the time, before you have typed a single letter of the next word. The app has been downloaded more than five million times, is free for the first 30 days and then costs £1.86. They probably predicted that it would be a success. **David Baker** *swiftkey.net*

PHOTOGRAPHY: ELISABETH HOFF. ILLUSTRATION: BILLY CLARK

VOLVO
MLB 060
V60



Spontaneous family getaways to the beach can be tough. Introducing the Volvo V60 Sportswagon, designed to help you say "yes" to throwing everything into the car and caution to the wind a bit more often. With power and efficiency delivered through Volvo's Drive-E technology, it's miles you'll eat through, not fuel. Driving is stress-free too with innovations like Adaptive Cruise Control* and at the top of every child's wish list – a dual screen Rear Seat Entertainment System*. So pack your bags and get away from it all. **The Volvo V60 is designed around you.**

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VOLVOCARS.CO.UK

Official fuel consumption figures for the Volvo V60 range in mpg (l/100 km): Urban 19.5 (14.5) – 55.4 (5.1), Extra Urban 38.7 (7.3) – 68.9 (4.1), Combined 28.5 (9.9) – 62.8 (4.5). CO_2 Emissions 237 – 119 g/km.

*Adaptive Cruise Control and Rear Seat Entertainment System are cost options.

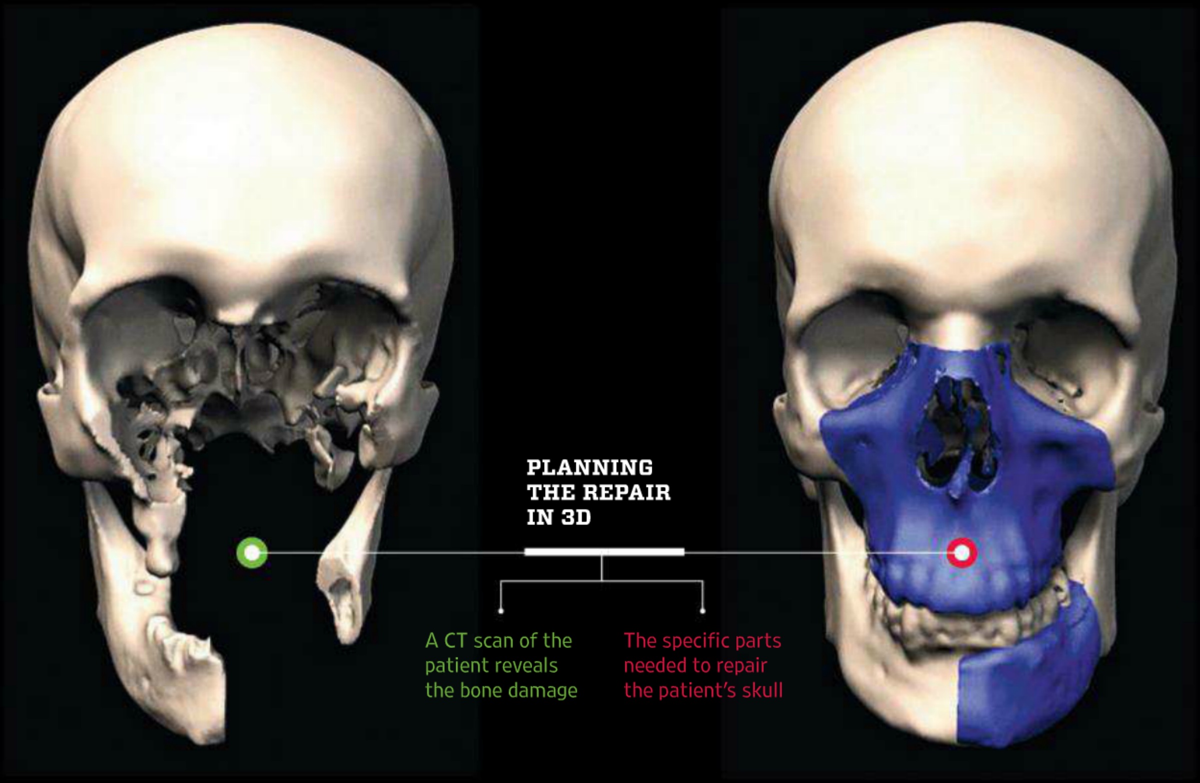
How 3D printing built a new face

The latest addition to a surgeon's toolkit is transforming patients' lives

In January, Belgian surgeons successfully performed the country's first full-face transplant – using 3D printing to streamline the procedure. A 65-strong medical team at Ghent University Hospital, headed by Phillip Blondeel, closely followed a virtual pre-operative plan devised by Materialise, a Belgian 3D-printing company. Engineer Joris Bellinckx and his team first scanned the patient's face with a CT scanner. Using custom 3D-visualising software, they examined the defects digitally and, based on this analysis, custom-printed anatomical models of healthy bones to use as a reference during surgery.

"We also printed a surgical aid to fit the lower jaw of a potential donor," says Bellinckx. "This guide sits on the donor's face during surgery and describes exactly where the surgeon needs to cut."

The painstaking planning eventually paid off. Six days after the surgery, ahead of anybody's expectations, the patient was able to speak. "He defied all odds," says Bellinckx. **MV** *materialise.com*



PLANNING THE REPAIR IN 3D

A CT scan of the patient reveals the bone damage

The specific parts needed to repair the patient's skull

PREPARE TO OPERATE

1. PLAN
The patient suffered from a severe, complex facial defect that affected bone as well as soft tissue. The lower jaw and mid-face in particular were completely damaged.

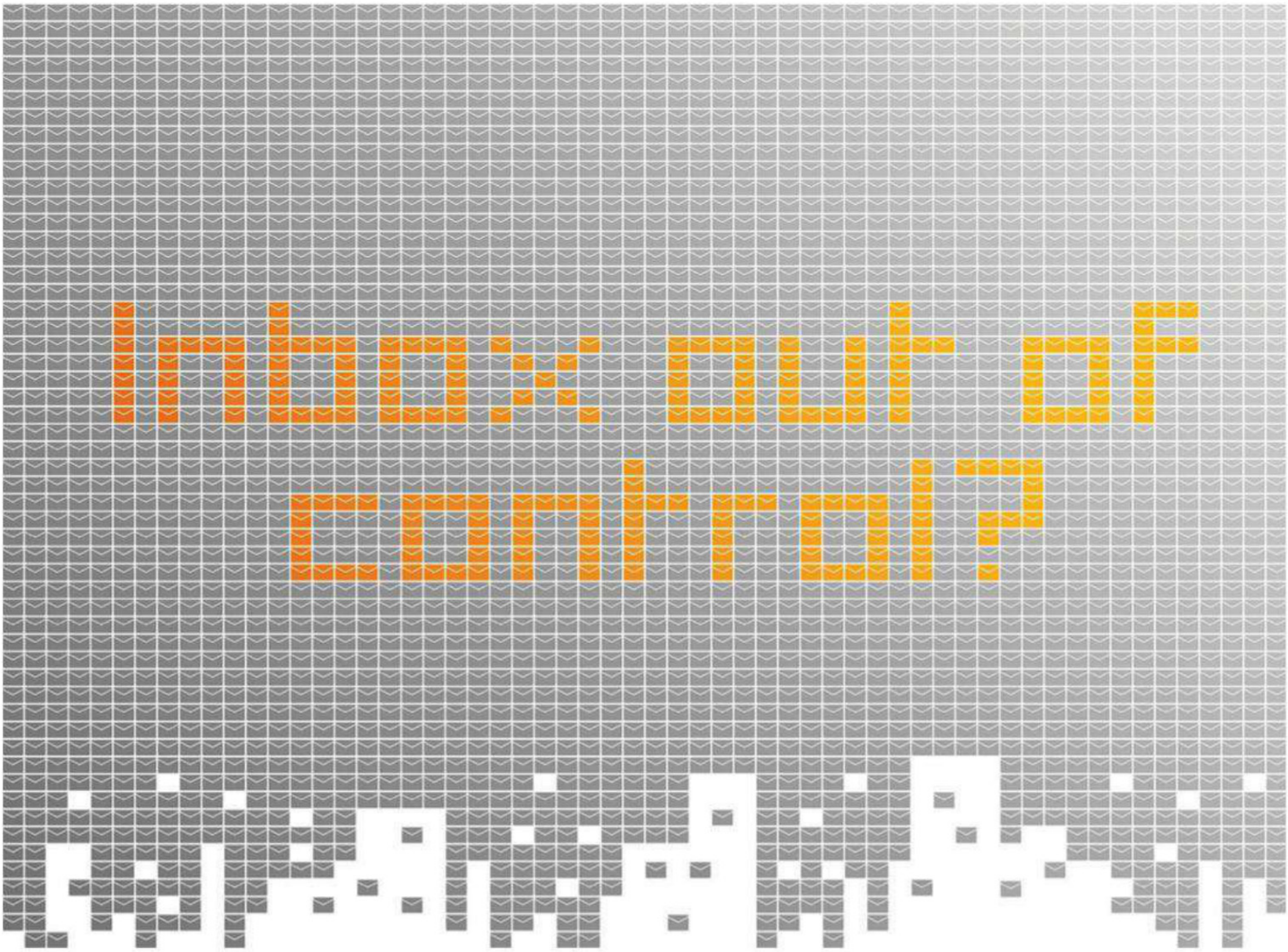
2. SCAN
A CT scan analysed the patient's facial anatomy. The image data was then imported into Synthes Pro-Plan CMF software, where it was used to build 3D models.

3. MODEL
By digitally "subtracting" the damaged skull from a normal skull in a healthy database, virtual models of "ideal grafts" that would repair the patient's skull were designed.

4. DESIGN
Based on the ideal graft and generic skull shapes, a "cutting guide" was designed. When placed on the donor's and patient's faces, these showed the surgeons where to make incisions.

5. PRINT
The cutting guides were 3D printed by Joris Bellinckx and his team. They also made anatomical reference models showing bone and flesh for use by surgeons during the procedure.

6. OPERATE
The 3D-printed aids ensured a perfect fit from donor to patient. Surgeons fixed the donor bones and face in place, then connected the blood vessels and motor and sensory nerves.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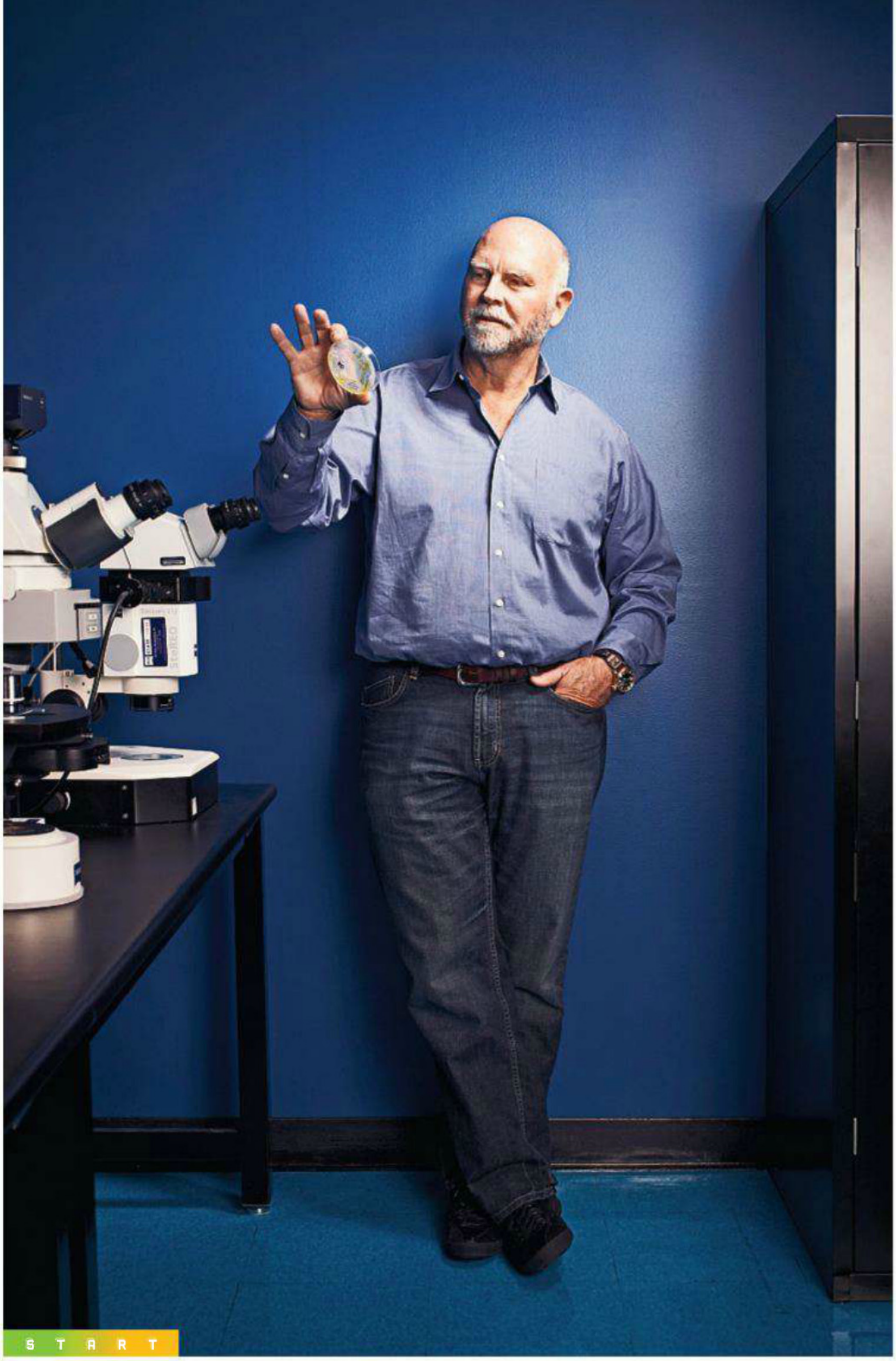

PHOTOGRAPHY: JOE PUGLIESE

Life hacker

He has sequenced the human genome and built a new organism – now Craig Venter wants to solve the world's energy crisis.

By Thomas Goetz

There is one version of Craig Venter's life story where he would've been a dutiful scientist at the US National Institutes of Health (NIH), a respected yet anonymous researcher in genetics, perhaps. Thankfully, Venter saw that storyline developing – and set about making sure it never happened.

Instead, in 1992 Venter left the NIH to head the nonprofit Institute for Genomic Research. Six years later he founded Celera Genomics, a brash rival to the NIH project that aimed to sequence the full code of the human genome. Venter had come up with a better technique – known as shot-gun sequencing – to get the job done, and it changed the way we translate genetics from proteins into code. Not incidentally, it also served as a model for today's Big Data explosion in science and research. In 2001 Celera officially "tied" the NIH to the genome finish line, though the company's sequence was more than a bit further along. (Celera's model genome, it just so happened, included Venter's own DNA.)

In the decade since, Venter has been on a tear of invention and exploration. In 2004 he sailed around the world, discovering thousands of new species and sequencing millions of new genes. In 2007 he unveiled his own genome, unexpurgated. And in 2010 he announced the first successful synthesis of life – a unique critter borne from two distinct organisms, thus proving that it is possible to create new organisms for specific purposes. He is a figure who has pushed science forward, sometimes by sheer force of will. ⟶

Craig Venter revealed his own genome in 2007. And it revealed his predisposition for risk-taking

WIRED spoke to Venter at an event in San Francisco hosted by City Arts & Lectures and the California Academy of Sciences.

You first made your mark on the international stage when your company, Celera, sequenced the human genome. Ten years on, what do you make of that work?
The last decade has been pretty successful on the technology front. Think about it: the human genome project started as a $3 billion (£1.8 billion) taxpayer initiative in the US with a couple more billion coming from foundations and governments overseas, so a total of about $5 billion. Celera's breakthrough was that we sequenced the human genome for a mere $100 million – we had a giant building full of sequencing machines. And now that giant building is condensed to something the size of this table, and that $100 million has been reduced to $1,000 or $2,000.

But what most people think about when it comes to genetics is personalised medicine. If we sequence your genome or my genome, what can we interpret, what can we predict for the future, what can we change? That's in its absolute infancy. We're at the point where we don't need one genome or just a few genomes to interpret your genome. We need tens of thousands of genomes as a starting point, coupled with everything we can know about their physiology. It's only when we do that giant computer search, putting all that DNA together, that we will be able to make sense in a meaningful statistical manner of what your DNA is telling you. We're just at the start of trying to do that. So the fact that it's ten years out and we're able to start on that project – that is exciting.

AGENT OF CHANGE

A decade ago Craig Venter described himself as a superenzyme: "I'm catalysing things," he said. Besides volatile institutional reactions, here are some breakthroughs the pioneering biologist has helped bring about **Rachel Gross**

1989

Expressed sequence tagging lets his NIH team discover hundreds of new genes by matching short DNA fragments to the chromosome

1992

Denied support to map the human genome using the efficient whole genome shotgun sequencing method. Leaves the NIH

1995

Now at the Institute for Genomic Research, he sequences the first genome of a living organism using shotgun sequencing

1998

Founds Celera Genomics; announces his bid to go head-to-head with the publicly funded Human Genome Project

2001

Celera and HGP tie, releasing drafts of the human genome in rival journals. Celera decodes the genomes of the mouse and rat

2004

Embarks on an around-the-world voyage in his yacht, *Sorcerer II*, to trawl microbes and sequence millions of new genes

2007

Reveals the first fully sequenced human genome. Surprise – it's his own

2010

Announces his team's creation of the first synthetic cell

There is some perception that in terms of human health the genomics revolution has overpromised and underdelivered.
Well, it depends on whose promises you're talking about. Some people were saying that ten years out we'd have every single disease cured. I think that was overpromising. I have always said that it was a race to the *starting* line. Once we got the first genome, that's when genomics would really start.

What about your own interest in human health? Where does that stand on the spectrum of what you're doing?
I turned 65 last year, and each year I get more and more interested in human health. For most people it happens around the age of 50, but I've always been a slow learner.

It's critical in terms of the cost of healthcare. If we can actually do this experiment of getting at least 10,000 human genomes and then get the corresponding phenotype information, we can show that this data set could make preventative medicine possible and thereby reduce healthcare costs. And one of the things about genetics that has become clearer as we've done genomes is that we're probably much more genetic animals than we want to confess we are.

What do you mean by that?
We're much more genetically determined in terms of our physiology. We have 200 trillion cells, and the outcome of each of them is almost 100 per cent genetically determined.

So on a cellular level, since the genes control the function of the cell, no matter what happens in that cell's environment, we're more the product of our genes than our environment.
Yes. And that has important consequences when it comes to reading our genomes, trying to understand the basis of disease, and then trying to alter those features. We're a country that seems to love drama and disasters. We're not so good at preventing them. But preventing disease is the future of medicine.

Another area that you have helped pioneer is synthetic life. It's built on the same raw material – DNA – as your work on the human genome, but it leads us in a very different direction, toward energy solutions, things like that.
"Synthetic life" means different things to different people. For some it's green monsters, for others synthetic means plastic. Most people didn't know what to make of it when we announced that we had created synthetic life. We're talking about chemical synthesis.

You started with a mycoplasma, one of the simplest bacteria.
In 1995 we sequenced the first genome of a living organism – in fact, we sequenced two. For the second, we chose the smallest cell that we could find, with the smallest genome. It was a species called *Mycoplasma genitalium*. It has only about 500 genes. Then we asked: could there be an even simpler lifeform? Could we get down to a minimal cell? And we

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set up all kinds of experimental ways to knock out genes and eliminate them from mycoplasma itself, whittling away. But due to a lot of complexity, you can't get there experimentally. We decided that the only way to get there was to make the chromosome – synthetically.

We had to develop all the technology and ability to do it, and it took us 15 years. We ended up converting the digital code in the computer into biochemistry. Starting with four bottles of chemicals, we rewrote the analogue molecule of DNA. And then we transplanted that synthetic DNA into a regular cell and booted it up, the same way you boot up software on a computer. We call this genome transplantation.

So now we had a cell of one species outfitted with the genetic software of another. In a very short time the cell converted into what the genetic software told it to do. There was no trace of the original species. Every protein in the cell came from the DNA we'd inserted. So we completely converted one species into another simply by swapping out its software.

And this wasn't just an academic exercise. You see a clear benefit in this ability to synthesise life for a specific function.
What we published was only a proof of concept. A lot of people say, well, the cell doesn't have any uses. But before we did that experiment most people thought it was impossible, so I think it was a pretty useful experiment as a proof of concept. And now we're working on trying to get cells to do what we want them to do.

But surely you're trying to get them to do something that's close to what they already do naturally.
Right. We're trying to harness photosynthesis. A key part of photosynthesis is what happens when the Sun goes down. Cells convert CO_2 into sugar and fat molecules. And they store the fat to burn as energy to get them through the night – the same way we store fat, only that's just to get us through TV shows. We're trying to coax our synthetic cells to do what's happened to middle America, which is store far more fat than they actually were designed to do, so that we can harness it all as an energy source and use it to create gasoline, diesel fuel and jet fuel straight from carbon dioxide and sunlight.

Energy is just one of your targets. You believe DNA can be used to solve all sorts of problems: health, energy, food…
I think of it as an equation: water equals food equals energy. If doesn't matter where you start in that equation, you need cheap renewable energy to produce food and clean water, and vice versa. Biology is a natural part of many of those, certainly the food part. And it's been a part of energy. Oil is ancient biology, as is coal, but we need to not take that ancient biology out of the ground, burn it and put it into the atmosphere. We need a way to recycle the biology. So biology will be a key part of the solution. Will it be the only solution? No. We need lots of solutions. We can now start with the code, the digital code of DNA, convert that into chemical DNA, and convert that into new living organisms that have the potential to do what we need them to do. Producing these very necessary things for society.

Just to touch on the ethics of this, why do you think it strikes a nerve in people that you're doing this with life, with organisms, compared to the tinkering and manipulation that's being done with, say, silicon? What is it about biology that is different?
I think because we're a part of biology and we relate to that. But the amount of fear this arouses depends on our education, it depends on people's religion. You see it in literature, the idea that "if you alter life forms it's going to lead to no good end". That goes back to Mary Shelley's *Frankenstein*, and you see it in movies – it's part of our culture. Perhaps it's an innate fear because we're a part of biology, so we're afraid of making things better or making them worse. But I think it's the most powerful technology we have at our disposal to change the outcome of humanity.

START

'Synthetic life means different things to different people. For some, it's green monsters'

Let's end with a big question: in 1990, Carl Sagan wrote that "We live in a society exquisitely dependent on science and technology, in which hardly anyone knows anything about science and technology." That seems even more true today. Do you think we respect science enough as a society?
The new anti-intellectualism that's showing up in [American] politics today is a symptom of our not discussing these issues enough. We don't discuss how our society is now 100 per cent dependent on science for its future.

We need new scientific breakthroughs – sometimes to overcome the scientific breakthroughs of the past. A hundred years ago oil sounded like a great discovery. You could burn it and run engines off it. I don't think anybody anticipated that it would actually change the atmosphere of our planet. Because of that we have to come up with new approaches. We just passed the seven-billion population mark. In 12 years, we're going to reach the eight billion mark. If we let things run their natural course, we'll have pandemics, people starving. Without science I don't see much hope for humanity.

EARTHQUAKE ABOUT TO STRIKE? JUST RISE ABOVE IT ALL

Having witnessed a series of earthquakes wreak devastation on his country, Japanese inventor Shoichi Sakamoto came up with a solution to protect buildings: houses that levitate.

His technology is simple. As the earthquake begins, a sensor inside the building detects the movement and switches on a compressor that pumps high-pressure air into two pockets between the house and its artificial foundation, lifting the building up to 3cm off the ground. A valve controls the flow of air underneath the building, keeping it steady as it floats. And when the shaking subsides, the air is released and the building gently settles back into correct position.

Air Danshin Systems, the company that markets and sells the technology, has already retrofitted the device to more than 90 properties across the country, and it hopes to install the system in larger buildings and factories that house sensitive or potentially hazardous equipment or materials.

Test footage reveals that a glass full of water will remain still even as the ground beneath shakes violently. And at a cost of around £23,000 per home, depending on size and location, it could offer relatively cheap protection from the country's tremors and tsunamis. One question: if we can now make houses levitate, where are our *Back to the Future*-style hoverboards? **Daniel Cossins**

ILLUSTRATION: JACK HUDSON

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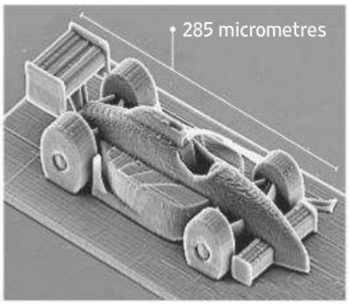


Small and speedy

This F1 car could fit inside the full stop at the end of this sentence. At 285 micrometres in length, it's about the size of a grain of sand. Photographed with an electron microscope, the model was created using the latest version of two-photon lithography or 2PP, a 3D-printing technique in which highly focused laser beams manipulate liquid resin into detailed solid structures.

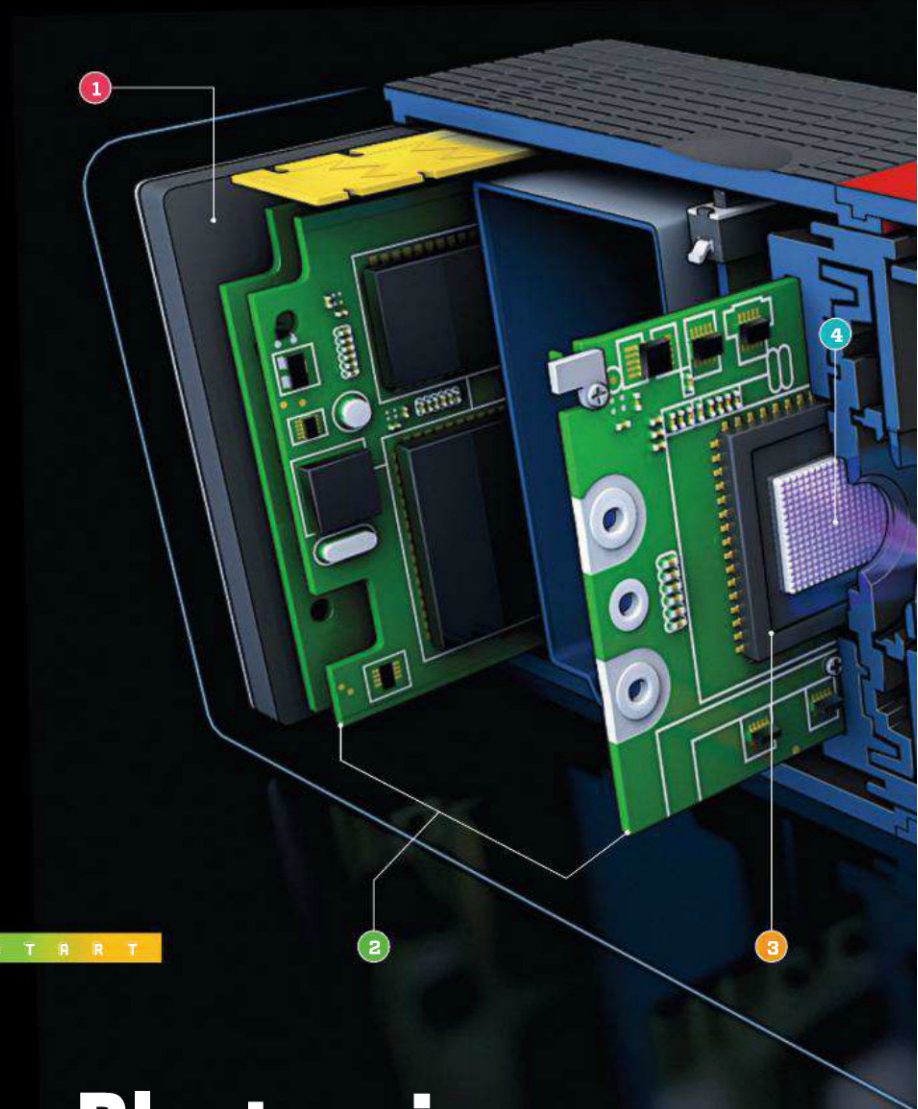
"The complexity and accuracy of the structures that can be produced are particularly suitable for making scaffolds for tissue engineering," says Jan Torgersen, 27, one of the Vienna University of Technology team that built the machine. "This is far more precise than commercial 3D printers and we're not limited to layer-by-layer fabrication."

Molecules in the resin, which induce polymerisation to make it hard, are activated when they absorb two photons at once – that happens only at the centre of the beam, hence the precision. It's fast, too. The car, made up of 100 layers, was printed in just four minutes. Drivers, start your 3D-printer's engines. **Daniel Cossins**

EARLY ADOPTER

What's exciting...
CHRIS LUEBKEMAN
Director for global foresight and innovation at Arup

"A diabetic Arup team member mentioned a new **iPhone app called *Glooko*.** A glucometer connected to a smartphone can upload blood sugar records, allowing users to see aggregated readings and how blood-sugar levels change over time."



START

Photos in full focus

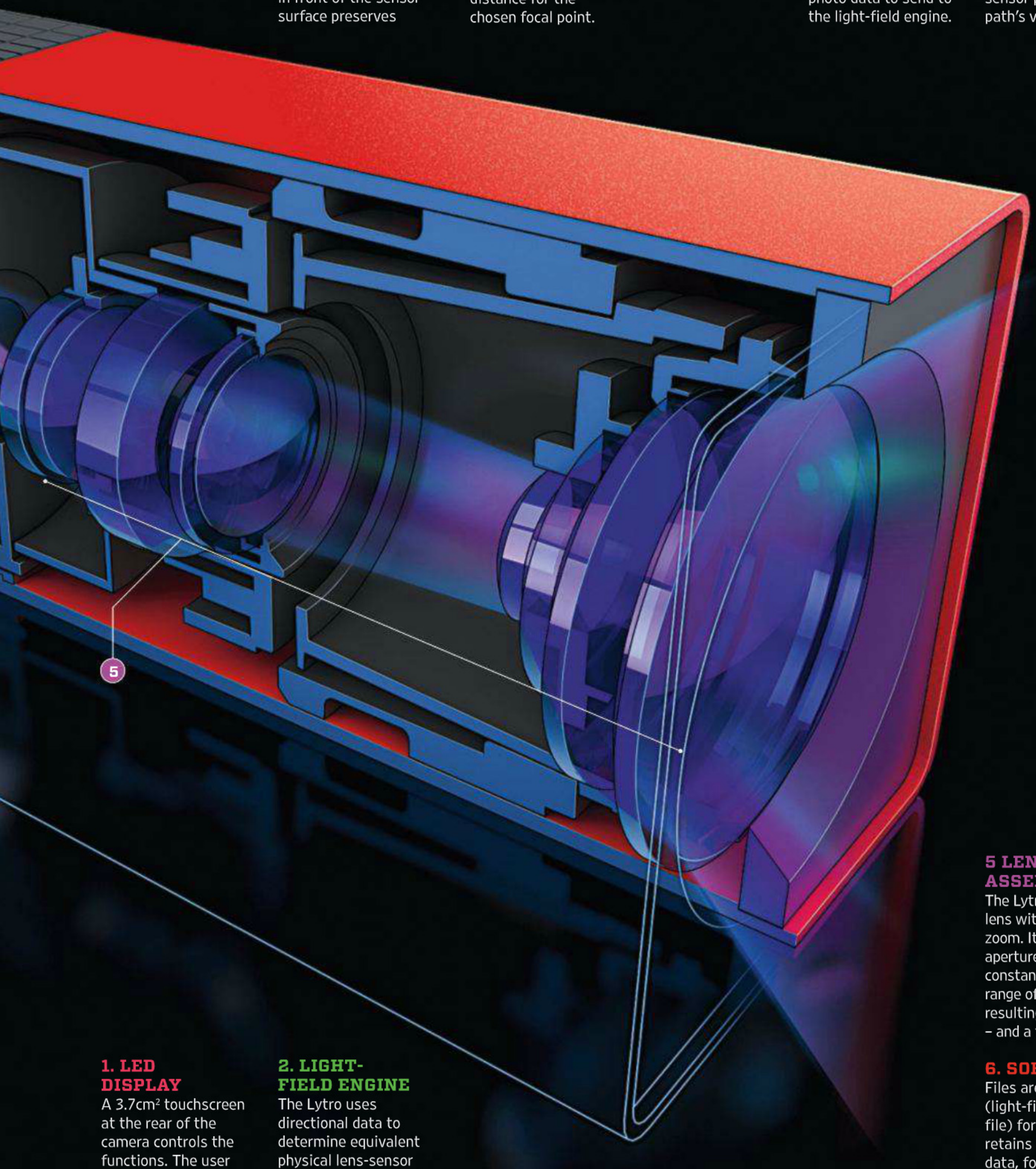
Forget the autofocus – Lytro is a point-and-shoot that lets you sharpen up afterward

The Lytro camera lets you focus photos after you've taken them. With no need to autofocus, images can be captured instantly and later sharpened up, shifted in perspective or manipulated in 3D space. Born out of inventor Ren Ng's PhD from the University of Stanford, the Lytro condenses the principles of light-field photography into a handheld consumer device. It could be the first step in a potentially major shake-up in photography. Here's a deeper look inside. **Jeremy Kingsley** *lytro.com*

CREDIT TO GO IN HERE

HOW IT WORKS

Rays of light entering the camera refract through the series of curved lenses and are captured on the light-field sensor. The micro-lens array in front of the sensor surface preserves each ray's direction. The light-field engine uses this information to process the image in 3D space, and determine the equivalent fixed physical lens-sensor distance for the chosen focal point.



1. LED DISPLAY

A 3.7cm^2 touchscreen at the rear of the camera controls the functions. The user can click on the image to refocus to the selected area. A sensor across the top adjusts the zoom.

2. LIGHT-FIELD ENGINE

The Lytro uses directional data to determine equivalent physical lens-sensor distance for any focal point. The light-field engine does this processing in the camera itself.

3. LIGHT-FIELD SENSOR

The light-field sensor captures the direction, colour and intensity of each light ray. The sensor records 11 million "megarays" of photo data to send to the light-field engine.

4. MICRO-LENS ARRAY

The micro-lens array consists of thousands of tiny lenses that fracture the light into thousands of distinct light-paths. The sensor preserves each path's vector direction.

5 LENS ASSEMBLY

The Lytro uses an *f*/2 lens with an 8x optical zoom. Its large aperture remains constant across the range of the zoom, resulting in a long lens – and a tubular device.

6. SOFTWARE

Files are saved in .lfp (light-field picture file) format. This retains the directional data, for editing with Lytro's desktop software. Images can be focused and exported as flat .jpegs or as "living pictures".

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Africa's mobile-phone connector

Gustav Praekelt is using simple SMS to network a continent

Gustav Praekelt believes SMS can change Africa. "Often, people try to build complicated solutions to big problems," says the founder of the South Africa-based non-profit Praekelt Foundation. "We build simple solutions." Praekelt's company creates mobile platforms to deliver free messages that bring a social benefit.

Out of a billion Africans, 650 million have active mobile connections. Tap into all these, says Praekelt, and you have your finger on the pulse of the continent. His first product, TxtAlert, launched in 2006, sends texts to 50,000 HIV patients in South Africa, Kenya and Tanzania telling them to take their medication and go to their doctors' appointments. The rate of appointment no-shows fell from 29 per cent to four per cent over three years. It also allows people to send a "please call me" message free of charge.

Next up: providing access to Wikipedia – without the internet. "In Africa, only one per cent have smartphones," he says. Taking advantage of the Unstructured Supplementary Service Data (USSD) protocol, Praekelt is working with network providers to let users search Wikipedia offline. "You can do this with a Nokia 1110," he explains, "and it's free." Good call. **MV** *praekeltfoundation.org*

Praekelt's ideas

- MAMA: parenting information via text for expectant mothers
- YoungAfrica Live: a social platform for young people to hold discussions
- Ummeli: an African LinkedIn for the young and unemployed

WIRED	TIRED	EXPIRED
UK Communications Bill	Iran Cyberspace Council	Great Firewall of China
Pocket	*Instapaper*	*Readability*
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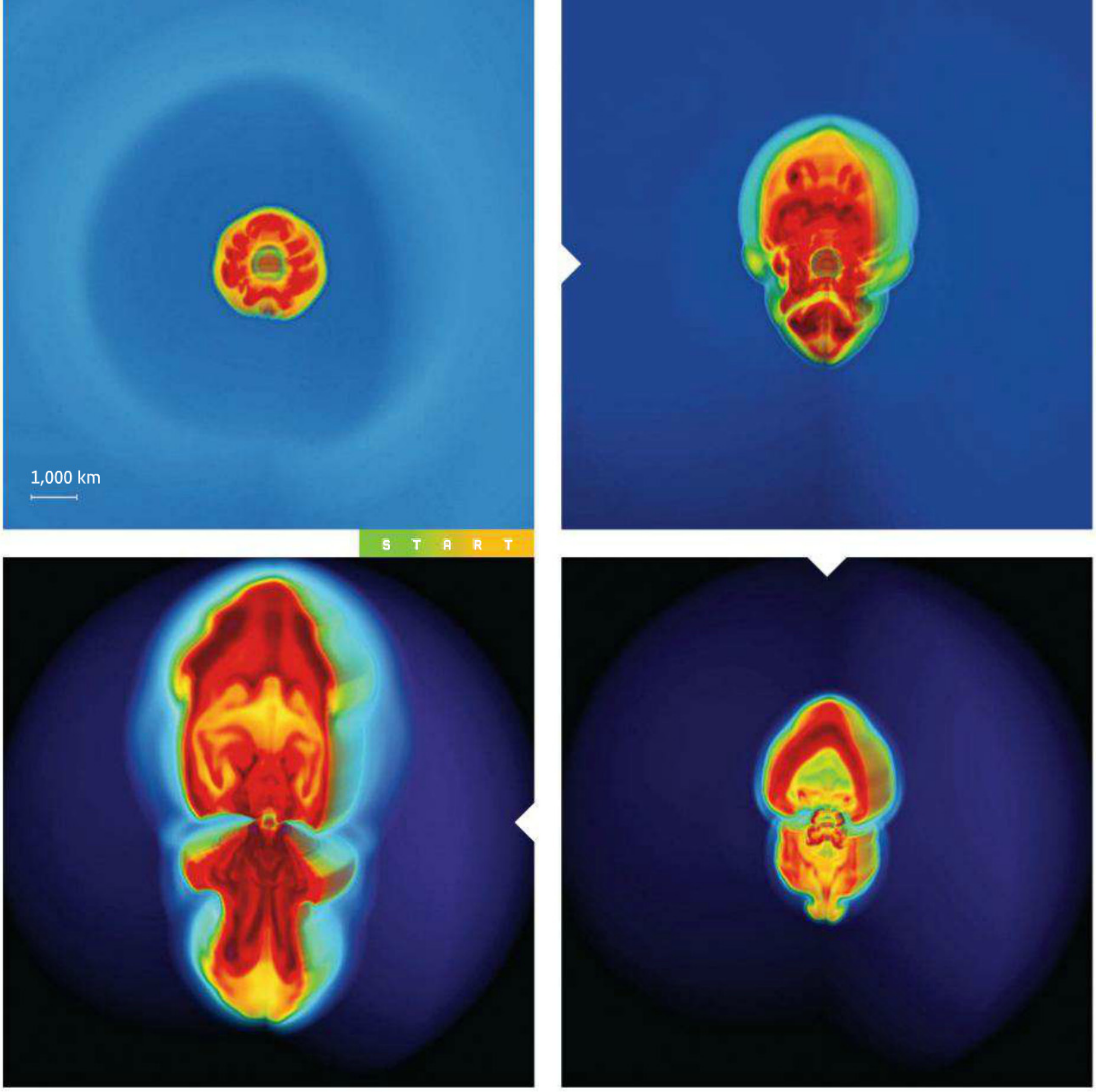

ILLUSTRATION: A MAREK AND THOMAS JANKA, MAX PLANCK INSTITUTE. RENDERING: MARKUS RAMPP, COMPUTER CENTRE GARCHING

Above: the first second of a supernova – the explosive shockwave reaches 10,000km per second

Supernova: the very early years

The first seconds of a supernova's life were secret – until 3D modelling recreated the star's big bang on a computer

“Supernovae are laboratories of nuclear physics,” says Thomas Janka. “But unfortunately you couldn't produce these conditions in a laboratory on Earth.” Instead, Janka and fellow astrophysicists at the Max Planck Institute for Astrophysics in Garching, Germany, use computer models to recreate supernovae on the desktop, employing powerful supercomputers to crunch the laws of physics into millisecond-by-millisecond simulations.

Supernovae are stars undergoing catastrophic explosions, forming neutron stars or black holes that are created by the biggest stars when they die. Although the later hours of a supernova are well observed, the first moments, beneath the blast surface, remain poorly understood.

“The big mystery is how exactly the explosion mechanism works,” says Janka, explaining how 3D computational modelling helps to recreate the supernova event's first milliseconds. By inputting fundamental physical laws, constants and equations well understood in isolation, Janka and his team examine how these laws work together to produce supernovae. Janka, 52, and other researchers are now adding the detailed microphysics of neutrinos (emitted in their billions in these explosions) to the simulations – but it's an enormous computational challenge. “That is a very big step,” says Janka. “It's really getting to the limits of what computers can currently provide.” Let's hope they don't have to wish upon an exploding star to get that equipment upgrade.

Jeremy Kingsley *mpa-garching.mpg.de*

EARLY ADOPTER

What's exciting...
HANS ULRICH OBRIST
Curator,
Serpentine Gallery

“One of the most intriguing projects is Russian director **Ilya Khrzhanovsky's *Dau***. He cast over 150,000 people and shot thousands of hours' material for the film, about legendary Russian physics guru Lev Landau. There will be a 21st-century ‘Dau’ theme park as well.”

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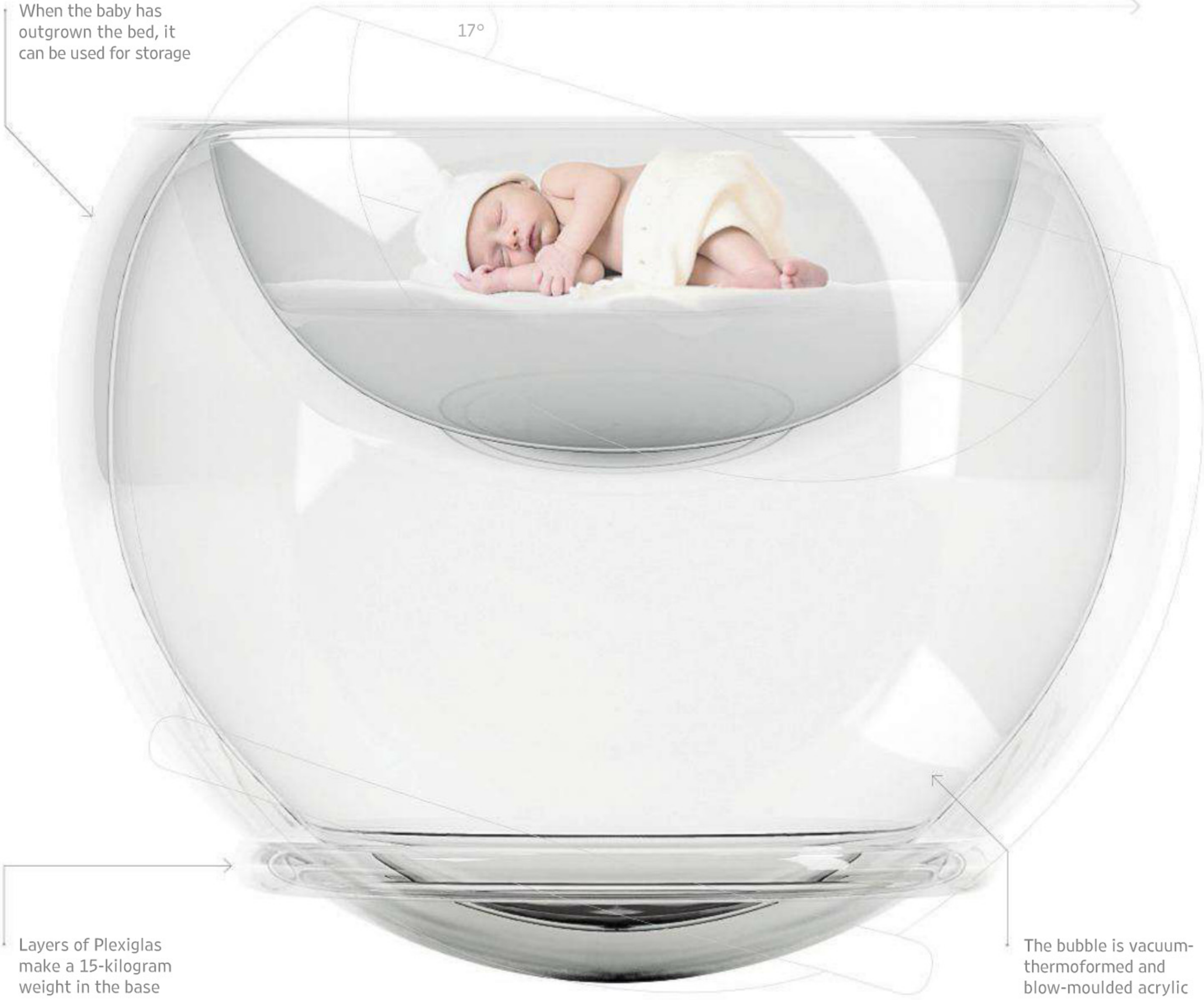
The baby in the bubble

This hypoallergenic bowl-shaped bed for newborns is designed to be so comfy and soothing, it will probably make parents jealous



When the baby has outgrown the bed, it can be used for storage

Layers of Plexiglas make a 15-kilogram weight in the base

The bubble is vacuum-thermoformed and blow-moulded acrylic

What do you get if you cross a soap bubble, an acrylic wash-basin and a traditional Russian toy? A bowl-shaped baby bed, according to St Petersburg-based product designer Lana Agiyan. Driven by a desire to create functional, unique appliances for babies, mother-of-two Agiyan created the bed for children up to five months old. "The baby is almost floating inside this acrylic bubble, and you can see its every movement," she explains.

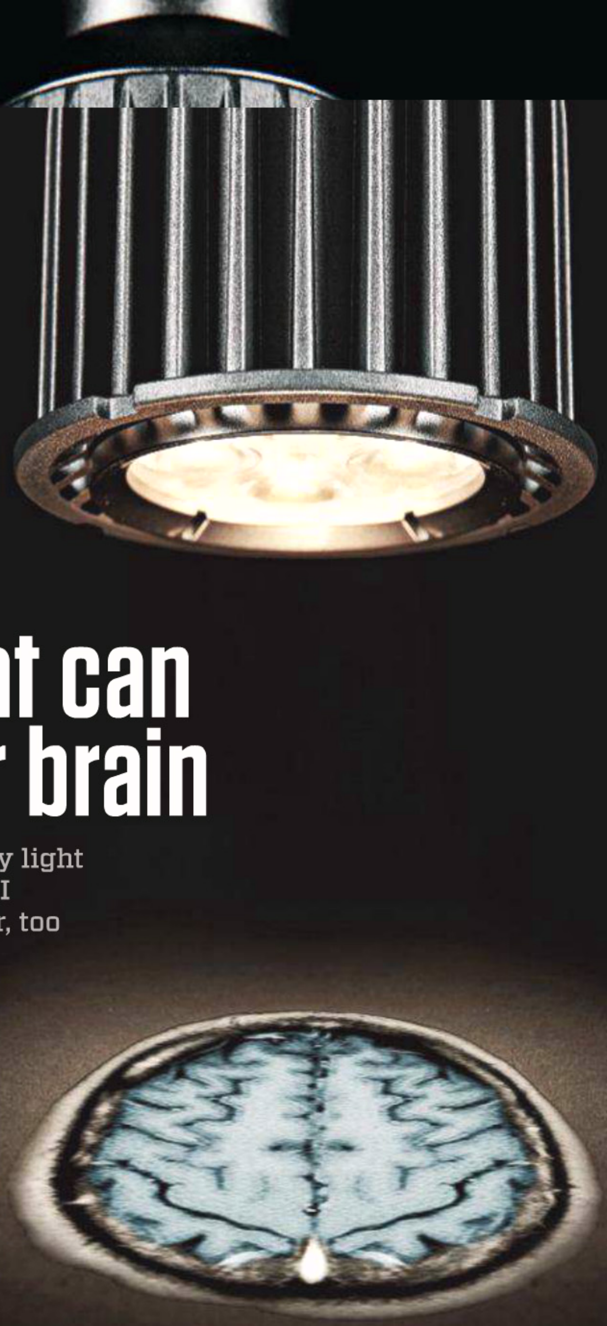
The Bubble Bed, which doubles up as a portable bathtub, is self-cleansing and anti-odour – it is coated with a special liquid polymer containing nano-titanium dioxide, which, when exposed to sunlight, begins to ionise and degrade dirt. The polymer also "heals" scratches in the surface which could potentially harbour germs. The bed can be tilted to 17° and is stabilised by layers of Plexiglas in the base which act as a weight centre. "I was inspired by a *nevalyashka*, a Russian tumbler toy – when pushed, it returns upright," says Agiyan, 28. The mattress is pure wool and is stuffed with buckwheat husks, a natural material that is antibacterial and antifungal.

START

Currently, Agiyan is working with Indian furniture designer Fenny Ganatra, who has agreed to manufacture the Bubble Bed through her brand, Bounce. Next in Agilyan's product pipeline? A night-light that helps babies sleep better by projecting colours and pictures on the ceiling. Agiyan says, "Everything I do is inspired by my own kids' needs." **MV** *lana-agiyan.com*

PHOTOGRAPHY: JENYA ZACHOROSHKO

Each month WIRED's chemist Dr John Emsley deconstructs an everyday product. He is the author of 110 research papers and ten books, including his most recent: *Nature's Building Blocks, 2nd edition* (OUP)



A bulb that can scan your brain

Shine a bright, low-energy light on things –and get an MRI image of your grey matter, too

INGREDIENTS
Arsenic
Gallium
Indium
Yttrium
Lanthanoids
Selenium

ARSENIC
Employed as gallium arsenide phosphide (GaAsP), this glows red-orange in an LED. Arsenic (in tiny amounts) is also vital to semiconductor production. In the past, arsenic could be found in weedkillers, rat poisons, cosmetics and medicines. Some medicines still use it.

GALLIUM
Gallium arsenide (GaAs) was the basis of the original red LEDs, joined by gallium phosphide (GaP), which glows yellow-green. It was gallium nitride (GaN) that revolutionised LEDs because it emits blue-violet light, completing the full spectrum of colours.

INDIUM
As indium gallium nitride (InGaN), this provides green LED light. Indium has a much wider role as indium tin oxide (ITO), which acts as an electrode in solar panels and flatscreen displays. Indium nitride, phosphide and antimonide are used in microchips.

YTTRIUM
Yttrium aluminium garnet (YAG) is used to coat blue-emitting LEDs, where it turns some of their light to other colours of the spectrum. Yttrium, as mixed yttrium, barium, copper oxide ($YBa_2Cu_3O_7$), is part of the superconductor magnets used in MRI equipment.

LANTHANOIDS
These are added to YAG to boost the white light. Cerium absorbs UV and re-emits it as visible light; gadolinium and terbium soften the light produced by YAG. Cerium oxide is found in catalytic convertors and gadolinium is used in regulating nuclear reactors.

SELENIUM
In LEDs, zinc selenide glows with a bluish light. When light falls on metallic selenium, its electrical conductivity increases 1,000-fold, and it used to be found in light meters, solar cells and photoelectric cells. Selenium compounds are still used in anti-dandruff shampoos.

PHOTOGRAPHY: SCOTT GRUMMETT; CORBIS

ONE TIMELESS LOOK,
THREE IRRESISTIBLE CHOICES

Everyone has a different lifestyle. That's why the new LG Optimus series was developed to provide you with the perfect screen size to suit your individual needs. No matter which one you choose, you're sure to stand out from the crowd with a timeless style piece. Stylize your view and bring style to life with LG Optimus.

LG optimus L7 L5 L3

www.lg.com/uk

LG
Life's Good

L3
Petite in Size,
Grand in View

L5
Versatile View with
Expanded Capabilities

L7
Pleasure to View

L
STYLE

The future will be here.
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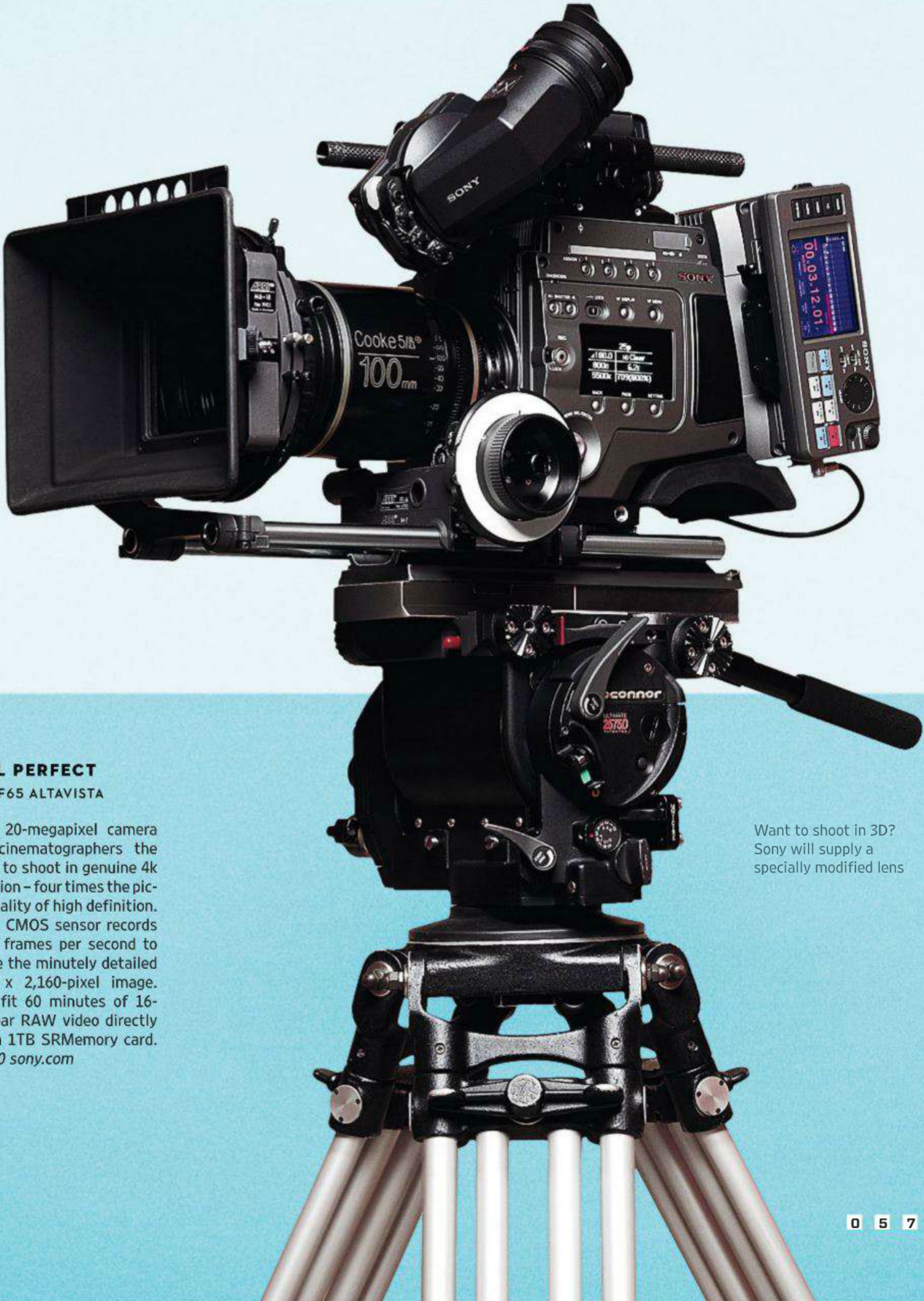
wiredevent.co.uk

FETISH

OBJECTS OF DESIRE
THIS MONTH: 07.12

- SUPER HD CAMERA
- POWER SUPPLY
- BIKE IN A BOX
- TRANSPARENT TECH
- FISHING REELS

EDITED BY **JIM HILL**



Want to shoot in 3D? Sony will supply a specially modified lens

PIXEL PERFECT

SONY F65 ALTAVISTA

Sony's 20-megapixel camera gives cinematographers the chance to shoot in genuine 4k resolution – four times the picture quality of high definition. The 8K CMOS sensor records at 120 frames per second to capture the minutely detailed 4,096- x 2,160-pixel image. It can fit 60 minutes of 16-bit linear RAW video directly on to a 1TB SRMemory card. *$65,000 sony.com*

PHOTOGRAPHY: PALMER & PAWELL. WORDS: JIM HILL

FIRE POWER

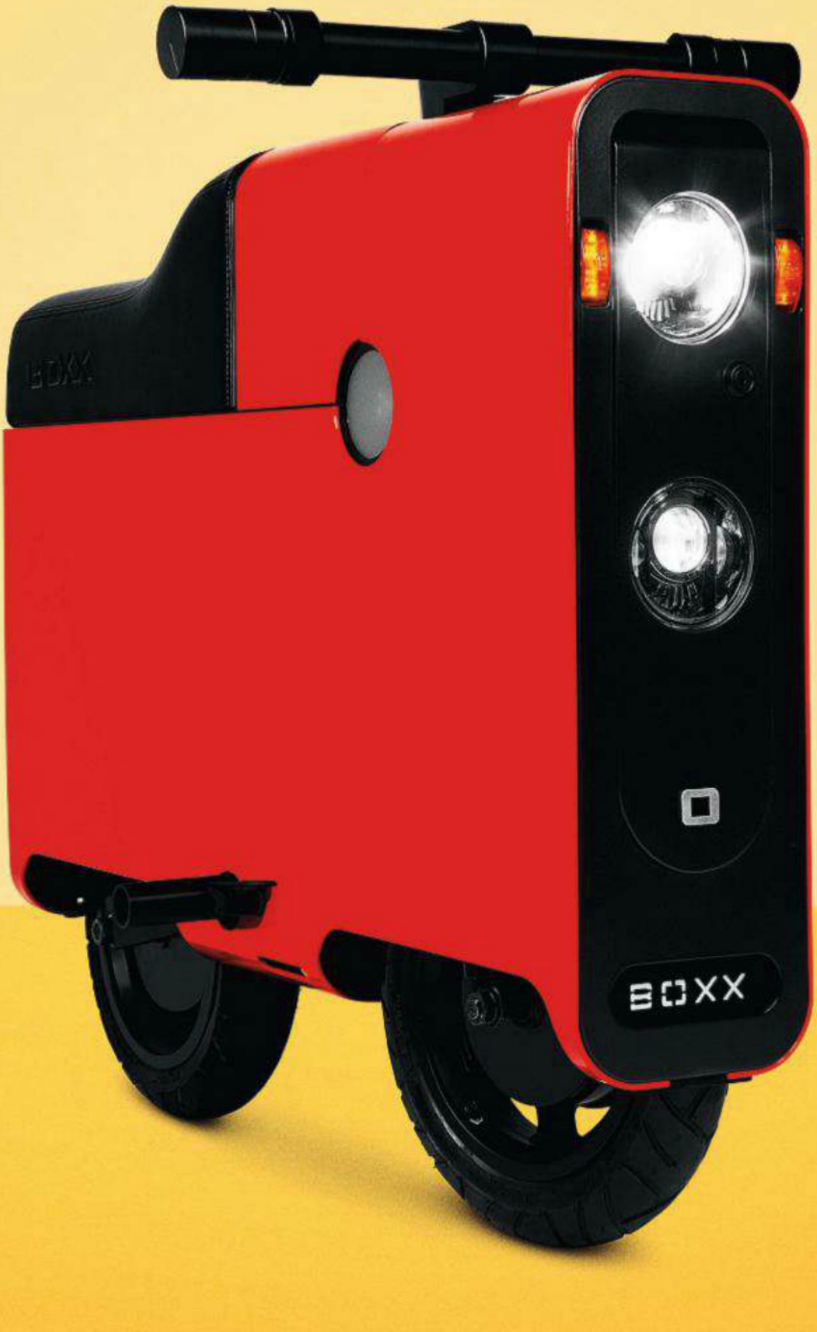
BIOLITE CAMPSTOVE

As well as heating your minestrone, this wood-burning camp stove can also charge your smartphone. A thermoelectric module converts the burning fuel's thermal energy into enough electrical power to drive a small fan that aids combustion. This can also be used to charge a small device plugged in via the USB port – handy for off-grid adventures. *$129 biolitestove.com*

Fold up the aluminium legs, and the 935g unit is just 21cm tall

PHOTOGRAPHY: PALMER & PAWELL. WORDS: JIM HILL

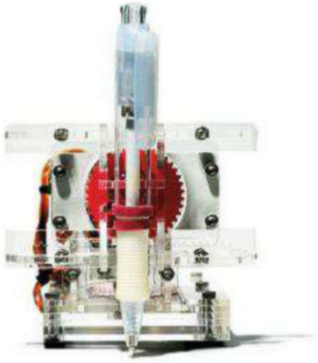
Want to ride it all year round? Optional extras include a heated seat



BOXING CLEVER

BOXX CORP BOXX

This one-metre-long electric bike offers two loading bays for your shopping. And that conspicuous profile, which other road users can easily spot, also has a surprisingly low drag coefficient. It means this 54kg monocoque vehicle can travel for 100km of considered riding on a single charge. The electric drive train turns both 25cm wheels for enhanced traction. *$3,995 boxxcorp.com*



CNC-BOT

DIATOM STUDIO PICCOLO

This tiny CNC computer-controlled robot is run using the open-source Arduino platform and comes with a library of software. Assemble and then hack it to do everything from draw tiny sketches, to work with other Piccolos to produce murals, to potentially laser-cut or 3D-print, depending on the tool attached. *Predicted RRP less than $70 piccolo.cc*

HIGH-END AQUARIUM

OCTOPUS STUDIOS SILVERFISH

A fish tank fit for a Bond villain, the Silverfish is designed for tropical freshwater specimens. The six interlinked chambers are made from polymethyl methacrylate and are assembled on site. The 2m^3 tank holds 230 litres of water and stands 1.4 metres high. The filtration, heating and lighting equipment are hidden inside the stand (not shown). *€5,000 octopusstudios.com*

TRANSPARENT TECHNOLOGY

SEE-THROUGH KIT THAT REVEALS ITS INNER WORKINGS

GLASS POOL TABLE

NOTTAGE DESIGN G-1

A glass pool table that plays like a fabric one? The secret is the transparent Vitrik surface that's layered on top of a 15mm glass base. The Vitrik ensures that balls roll at a similar rate to those on traditional cloth/slate tables, can be spun (to slightly more aggressive effect) and are similarly silent. Tables are available in 2.4m x 1.2m or 2.1m x 1m. *From £26,000 nottagedesign.com*

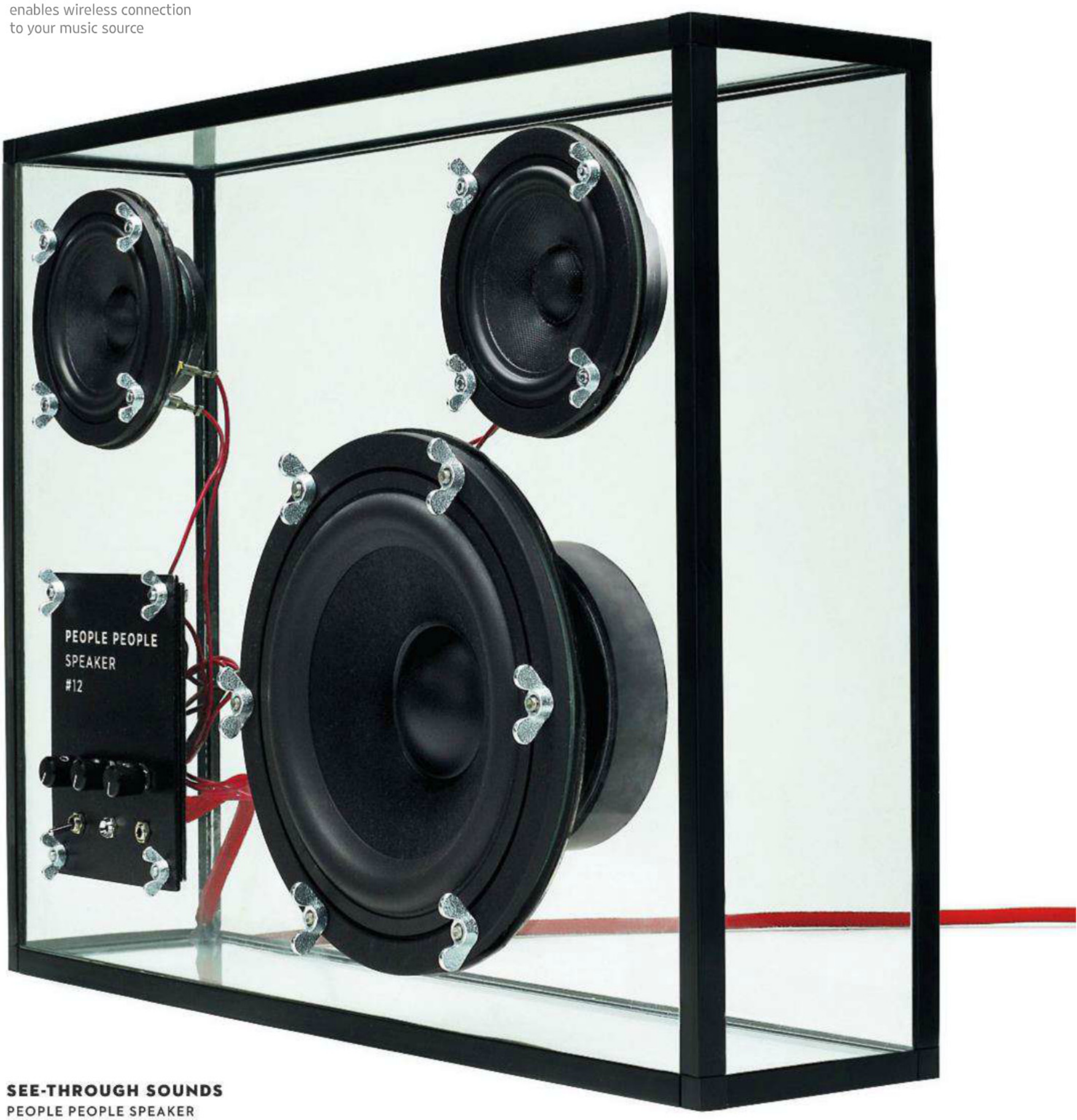
SYPHON COFFEE-BREWER

HARIO TCA-2

This two-cup, 240ml heat-resistant glass siphon coffee-brewer is designed to extract maximum flavour from your ground coffee. Using a spirit burner to heat the water in the lower chamber creates pressure that forces hot water into the upper brewing chamber. Then, as the lower chamber cools, the coffee is sucked back down, through a cloth filter. *£80 amazon.co.uk*

PHOTOGRAPHY: ALI MOBASSER. WORDS: SIMON MUNK

A rechargeable antenna enables wireless connection to your music source



SEE-THROUGH SOUNDS

PEOPLE PEOPLE SPEAKER

To reduce shipping costs, this speaker arrives as a flat-pack kit containing all the electronics, speaker cones and assembly instructions – but no glass case. You buy the 6mm tempered glass, to the supplied template, from your local glazier. But if your glazing skills are lacking, the Swedish design consultancy will also sell you a ready-made speaker. *€500 (assembled) peoplepeople.se*

BIG GAME HUNT[redacted]

EINARSSON INVICTUS [redacted]

Made in Iceland from anodise[redacted] aluminium, this large single-pin fly reel is design[redacted] for landing heavy and muscular fish such as marlin and sailfish. The spool has a soft breakin[redacted] system that absorbs the shock as the fish th[redacted] on the hook. And by reducing the potential for snapping the line, you have a wider choice of tackle at your disposal. *£635 farlows.co.uk*

The microfibre PowerPro line shown here can bear loads of up to 30kg

TROLL CATCHER

ABU AMBASSADEUR 7000 SERIES

This popular bait-casting (or multiplier) reel is ideal for trolling (fishing from a moving boat), thanks to its calibrated line counter that allows you to measure out your line. It also has a loud bite-clicker to alert you to a potential catch. The brass gears have a ratio of 5.3:1 meaning you can reel in more quickly than your average multiplier reel. *£107.99 farlows.co.uk*

SALTWATER SPINNER

SHIMANO STELLA STL10000 SW

As you might expect from a brand synonymous with cycling, Shimano's reel uses a sophisticated gear system to help anglers tame frisky fish. The same line-management system also reduces the chances of snaring the line when casting and ending up with the dreaded "bird's nest". The spool is coated in ceramic to combat saltwater erosion. *£844.99 farlows.co.uk*

FISHING FOR THE FUTURE

HIGH-TECH TACKLE FOR THE FORWARD-THINKING ANGLER

SURF CASTER

QUANTUM CABO PT C980

The frame and spool of this spinning reel are made from aircraft-grade aluminium and the bail is titanium to impede the corrosive effect of saltwater. But to be sure of its durability, six layers of protective coating have also been applied. The continuous anti-reverse mechanism helps avoid a slack line while you wait for the fish to bite. *£234.50 farlows.co.uk*

TUNA TAMER

HARDY FORTUNA X4

As the name suggests, this heavy-duty, salt-water-proof, anodised aluminium centre-pin reel is designed for landing big tuna. Its drag system, the in-built inertia design that prevents big fish from snapping the line, can handle 14.5kg of sudden force. Meanwhile, the multi-carbon disc-brake mechanism stops your line playing out as the fish fights. *£749 sportfish.co.uk*

PHOTOGRAPHY: ALI MOBASSER. WORDS: JIM HILL

SONOS
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IDEAS BANK

BRAIN FOOD AND PROVOCATIONS

THIS MONTH: 07.12

JULES EVANS_ROBERT NORTON_CLAUDIA HAMMOND_DALJIT SINGH_ANDREW BLUM

JULES EVANS_

The religious are all psychotic (in a good way)

Recently I was at the wedding of an old school friend. The friend has since discovered Jesus in a big way. The congregation was split down the middle – 50 per cent were young evangelists, swaying with their eyes closed and hands in the air; and 50 per cent were old school friends, tight-lipped and looking very uncomfortable amid the rapture.

I had evangelists either side of me at dinner. The woman on my right was beautiful, charming and, technically speaking, psychotic. I mean that in the nicest possible way. Her eyes grew wide as she told me how God regularly spoke to her, cared for her, entered her. She believed she had witnessed many miracles, that her eyes had been opened to a hidden level of reality.

A western psychiatrist would nod and tick off the classic symptoms of psychosis: hearing voices, feeling guided by spirits, feeling singled out by the universe, believing you have magical abilities to save the world. Our psychiatric wards are full of people locked up for expressing such beliefs.

We define ourselves, as a culture, by our attitude to such experiences. Before the modern age, they were very common and were categorised as heavenly or demonic visitations. Some of the founding figures of civilisation were, technically speaking, psychotic: Socrates, the father of western rationalism, had a daemon who gave him orders.

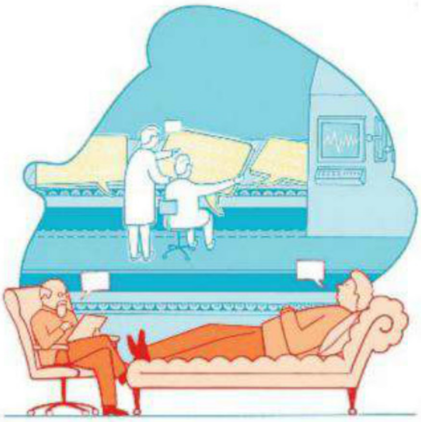
But since the 17th century such phenomena have been shifted to the margins of our secular, scientific, post-animist culture and defined as pathological symptoms of a physical or emotional disease. Today, if you tell your doctor about such experiences, you are likely to receive a diagnosis of schizophrenia and be prescribed debilitating anti-psychotic drugs.

And yet such experiences are very common. A new paper by Heriot-Maitland, Knight and Peters in the *British Journal of Clinical Psychology* (*BJCP*) estimates that 10-15 per cent of the population encounter "out-of-the-ordinary experiences" (OOEs) such as hearing voices. By automatically pathologising and hospitalising such people, we are sacrificing them to our own secular belief system, not unlike the Church burning witches.

Now, some scientists are trying to find a more sympathetic way to understand OOEs, to help people to integrate them and find value and meaning in them. Of course, many people find such experiences deeply distressing and actively seek medical help. But not everyone does. As the authors of the *BJCP* article note, OOEs can often be deeply emotionally fulfilling and meaningful for people, particularly if those who have them don't get hospitalised.

Whether an OOE is integrated or not depends, the authors say, on whether the person finds a supportive social context to help them make sense of the OOE, such as a religious organisation, a network such as Hearing Voices, or a sympathetic and open-minded therapist.

Perhaps we need to find a more pragmatic attitude to revelatory experiences, an attitude closer to that of William James, the pioneering American psychologist and pragmatic philosopher. James studied many different religious experiences, asking not "Are they true?" but rather "What do they lead to? Do they help you or cause you distress? Do they inspire you to valuable work or make you curl up into a ball?"



We can evaluate the worth of a revelatory experience without trying to find out if the experience "really" came from God or not.

Take the example of Alcoholics Anonymous, one of the most successful social organisations of the last 100 years. The founder, Bill Wilson, overcame his alcoholism when he had a religious vision after taking the psychedelic drug belladonna. That's interesting, but what's more interesting is the practical work he did after the vision, which helped millions of people.

Many of us will experience an OOE at some point. You may decide you are uniquely blessed by God. You're not. It appears our species' inbox is being constantly filled with messages from beyond (God, the unconscious, aliens, wherever). Some of these messages are useful, others less so. It's what you do with them that counts.

Jules Evans is the author of Philosophy for Life and Other Dangerous Situations *(Rider Books) and writes the blog philosophyforlife.org*

ILLUSTRATION: LAURIE ROLLITT

ROBERT NORTON_

Let's liberate our nation's art from the profiteers

In room number 56 of the National Gallery in London is *The Arnolfini Portrait*, one of my favourite works of art, and one that I could legally publish myself if I had access to a high-resolution file. Unfortunately the National Gallery does not let me freely download their file, but instead points me to its licensing section and price calculator.

The National Gallery's aim in its own words is to encourage "access to the pictures for the education and enjoyment of the widest possible public, now and in the future". Yet we already know that the widest possible public resides on the web rather than in the number of feet that pass through the gallery's doors daily.

As cofounder and CEO of s[edition], a digital platform for contemporary art, I respect the value of artistic copyright but believe equally in allowing unfettered access to the highest-quality reproductions of artworks already in the public domain. Unfortunately, not enough museums, galleries and public institutions share these views.

The National Gallery is not alone in refusing to send out high-resolution image files of artworks. This is not only unjustifiable from a legal point of view, but also bad policy and judgment by those whom the nation has entrusted to look after its works.

In December 2001, the UK government, under then prime minister Tony Blair, guaranteed that flagship museums and art galleries would be free. In the next decade the Tate Modern, the British Museum, the Natural History Museum and the Victoria & Albert Museum all had record attendances. The Tate claimed to be the world's most popular modern-art museum.

Now is the time for the coalition government to act boldly and herald in an equally exciting new chapter for the visual arts online: to scrap licensing fees for public-domain works of art. These quasi-copyright assertions and licences are the digital equivalent of museum entry fees, and they prevent us from using, learning from and simply enjoying these art resources.

A digital renaissance in the visual arts is under way. Improvements in screen resolution coupled with faster broadband and more sophisticated digitisation technologies will create compelling ways to access and experience art online. New initiatives such as Your Paintings, a joint effort by the Public Catalogue Foundation and the BBC to catalogue the UK's collection of 200,000 oil paintings, or the Google Art Project, which has now attracted over 150 museums across 40 countries, allow online visitors unprecedented access to artworks and provide new levels of brushwork detail.

Last year Yale University became the first art institution to announce it would provide licence- and royalty-free access to digital images of public-domain materials in all Yale collections. Far from having a price calculator, it makes no charge for downloading the 20MB, 300dpi TIFF file of any of Yale's public-domain works.

I spoke to Kenneth Hamma, consulting information architect at the Yale Center for British Art, who described the two-step process in adopting this open-access policy. The directors of the museums and libraries first convinced themselves this was the right thing to do partly because the licensing revenues were small, but more importantly because they didn't feel it was their responsibility to determine how these images could be used. After this idea was presented to the officers of the university, they took five minutes to make a decision. It was a no-brainer.

"Yale is about educational research and creativity, not about creating little revenue streams from licensing," Hamma explains. "The collections are suddenly much more accessible and public, which is a good thing and is, of course, why these institutions have these collections in the first place. It is why they are indeed funded to have these collections."

In March 2012, the US National Gallery of Art in Washington announced its own open-access policy for more than 20,000 works. As more works are freely distributed online by the world's leading and most respected institutions, the licensing model for public-domain works will eventually fall apart.

And when that happens, the world will become a better place.

Robert Norton is CEO of s[edition] seditionart.com

ILLUSTRATION: LUKE FENECH; YELLOWHAMMER. PHOTOGRAPHY: (CLAUDIA HAMMOND) IAN SKELTON

CLAUDIA HAMMOND_

Your memories are made to be reliably unreliable

We might well curse our memories when they let us down. But we might also be shocked by the results of the decades of work by the psychologist Elizabeth Loftus showing how easy it is to implant false memories into our minds, whether of kissing giant frogs or meeting Bugs Bunny at Disney World Manchester. We might worry about what it means for justice if an eyewitness can be so easily swayed by a leading question.

But there's a good reason for the fallibility of our memories. It allows us to time-travel mentally, at will, in the opposite direction – into the future.

After more than a century of systematic research into the way our memories work, psychologists are turning their attention to the way we imagine what's coming. The most significant finding is the degree to which future thinking relies on our memory for the past.

The evidence for this comes from a range of sources. In addition to forgetting the past, people with amnesia often find it difficult to imagine the future. Endel Tulving, the influential memory theorist, was met with a blank when questioning a patient about what he might do the next day: such patients struggle to imagine a future when asked to do so, but they appear to have no desire to imagine one either. It's since been found that these patients find it particularly hard to imagine the spatial elements of a situation in the future. When asked to imagine a future scenario where they were standing in a museum, they were unable to suggest what features they might see, whereas people without a brain injury might describe a marble floor or domed ceiling. Likewise, very small children find it hard. In one experiment only a third of three-year-olds could give a plausible answer as to what they might do the next day.

To envisage the future we rely on memory, recombining any relevant recollections to create possible outcomes. This remix of memories allows us to preview future events in a window in the mind. Memory is essentially a reconstructive process; when we want to re-experience an event we don't summon up a tape from the library – we alter memories as we lay them down in order to make sense of them, then we reconstruct them when we recall an event and even change them again if new information has come to light. A similar process takes place when we imagine the future – the neural signatures of remembering the past and imagining the future are remarkably alike.

If memories were fixed like videotape recordings, then imagining a new situation would be challenging. For instance, you can picture yourself arriving by double-decker bus at a tropical beach for the wedding of Johnny Depp to your best friend next week. To do so you need to do the equivalent of finding your personally recorded memories of sitting on buses and visiting your best friend, before ordering clips from the mind's archive of films starring Johnny Depp and TV programmes featuring tropical beach weddings – memories which could be decades apart. Then you splice all these elements together to create the scene. Cognitively it sounds like hard work, but the flexibility of our memories makes it relatively easy to meld these memories together to invent a scene that we've never witnessed before.

This is the key to travelling forwards in time in our minds: millions of fragments of memories from different times of our lives are not set in stone – they can change, giving us endless, instant imaginative possibilities for the future.

Claudia Hammond presents All In the Mind *on BBC Radio 4 and is the author of* Time Warped: Unlocking the Mysteries of Time Perception *(Canongate)*

DALJIT SINGH_

Luxury must become interactive to survive

At first, luxury and technology don't seem to be natural bedfellows. Luxe is defined by exclusivity, whereas tech is invariably mass market – and although it doesn't always want to be seen, it still needs to have its output firmly felt. Luxury is designed to be conspicuous, sending out specific signals from the owner to the onlooker – it has a material presence; technology is more discreet. Screen-based products are relentlessly updated and can't retain their value for as long as a tangible luxury product, which is perceived to appreciate in value over time. But there are parallels: they both embody craft, an inherent quality of material and design execution brought to life in an experience.

They continue to transform our lives, but digital technologies are rarely acknowledged in the luxury world. Is this because there is less focus on the object and more on the experience, the value of which is harder to quantify. The question "Can money buy a luxurious interface?" has led me to wonder about the value of materials, and whether one could create new artefacts and materials that go beyond the notion of content, embedding technology and interface at their core to create a new type of luxury. It's beginning to take off in the digital-art field through watermarking and distribution, but my interest lies in how and when it will impact other, parallel industries. Luxury brands have an opportunity to back, build and nurture a new type of relationship between technologies and their respective crafts. To combine the two is to capitalise on the new wave of luxury and to push technology, interface and digital design into a wonderful dynamism. Luxury also has the clear advantage of loyal followers who are willing to invest themselves, their money and their time.

This creates an extraordinary opportunity to push the boundaries. Luxury is an industry striving for superlatives across design, craft and production to create the ultimate products for a wealthy audience. So can money buy the ultimate interface? The answer is most definitely yes. It's a sector that can transform and innovate to create a new value – products which won't be studded by precious materials, but will however become luxurious through the interactive experience or imbued emotional qualities.

From cars to televisions, interface is so often the dropped ball in luxury products. Why don't these objects benefit from a seamless extension of a brand's design rigour? The pleasure of these luxury products is often diluted by the inferior digital experience. The perceived luxury is in the styling of the casing rather than the functionality or interaction with it. This merely apes what a watchmaker might do, rather than celebrating digital design for the possibilities it opens up.

Digital designers can create beautiful interactions, which take much crafting to produce – but they can't compete with a Rolex watch or a Cartier brooch in having "brand-plus-material" value. What if we could create products embodying a new type of value? Perhaps a ring with a single pixel instead of a diamond, or a watch with a black face that comes alive only to tell you to slow down and smell the coffee? If the pixel were from Google and the watch a partnership between Piaget and a notable interface designer, maybe we could create a new type of luxury. What if luxury were perceived as a surface that adapts, chameleon-like, to suit the mood or occasion rather than a traditional material that endures – a kind of adaptive layer?

The luxury industry could be an amazing protagonist and supercharge technical innovation – exploring those high-end technologies deployed by the military and medical sectors to see how they could be transformed. As our computers become embedded into the fabric of our environments, we need to establish new design rules to guide them. Let's reconsider the dynamic surfaces R&D departments have been developing for years at a bijou scale. Let's explore how robust, exquisite code can weave sublime experiences into products and services in this most rarefied of sectors, creating a new value for luxury.

Daljit Singh has been working in the interactive design sector for 17 years and is now the executive creative director at Conran Singh, an interactive design consultancy (conransingh.com)

ANDREW BLUM_

Don't be fooled by the cloud: the web is physical

As Arthur C Clarke has never let us forget: "Any sufficiently advanced technology is indistinguishable from magic." But when it comes to the greatest technological advancement of all – the one that consumes every moment of our waking lives and has only begun its transformation of global society – it's time to pull back the curtain. I'm talking, of course, about the internet. Not in the form that momentarily manifests on your screen, but the actual global colossus of physical wires and machines – that thing we've increasingly come to call "the cloud". The trouble is that the fantasy of "the cloud" creates an obfuscation that threatens the health and future of the real, physical network.

At some unnoticed moment between our dial-up modem's last primal scream and the evening we first laid a smartphone beside us on the nightstand, we were subjected to an infrastructural lobotomy. The internet became a universal human right and, therefore, more of an idea (however transcendent) than a physical thing. The specifics – short of our own router, blinking unreliably behind the couch – slipped away. We stopped thinking of the internet as an actual physical network and gave in to the notion of it as something untouchable and indistinct.

To lose sight of those specifics is to lose control. Each time we move another piece of our digital lives into the cloud, we give up a little more responsibility for it. Google will sort and track your email (but won't tell you where it's kept). Apple will cache your music library. Facebook will store – in perpetuity and, apparently, for free – your photographs. There are powerful conveniences in this, to be sure, but there are dangers too. At the least, we risk an accidental violation of privacy. At worst, we recognise that our thoughts and relationships are no longer fully our own. When an authoritarian government cuts off its citizens' access or when an ISP decides to start capping your bandwidth, the range of the internet's possibilities becomes constrained.

There's a conversation to be had about all that, but there's a basic knowledge that has to come first. We need to recognise that the internet has parts, before we can understand its potential. The thing to remember is that the internet exists. It is made of places you can visit – real buildings. I know, because I've been there. I've felt the exhaust of London's most important router, and gripped the end of a cable that crosses the Atlantic.

There's an analogy to be made with the sustainable food movement. A decade ago, food came from the supermarket. Today, as we walk down the grocer's aisles we're greeted with maps, charts and pictures of smiling farmers. We gain some satisfaction in knowing where our things come from, but more importantly that awareness itself is the outward display of internal changes. We couldn't talk about new ways of producing food until we knew how and where it was produced in the first place.

The same goes for the internet. To imagine a future for the network that isn't only blisteringly fast but also brazenly free requires knowing something of its existing structure – knowing where our internet comes from. At the moment, though, the frictionlessness of its interconnections – the myth of the cloud – lets us ignore the specifics. The cloud carries us through the day in a mild ecstasy of message chirps and finger-smudged screens. But the biggest technology of all, the one that defines our days more than any other, should no longer be relegated to the realm of the hidden and incognisant. To cede knowledge of those specifics is to cede control. If the internet seems like magic, realise that we're not the magicians, but the children, standing in awe of the illusion. As Neal Stephenson put it, writing 16 years ago in this magazine: "WIRED people should know something about wires."

Andrew Blum is a New York-based journalist and the author of Tubes: Behind the Scenes at the Internet *(Viking)*

ILLUSTRATION: DANIEL HASKETT

2 SHORTER BACK-FOCUS

The X-Mount has a short flange back-distance of 17.7mm. This means the rear lens elements are as close as possible to the sensor. The wide opening allows the lens to be mounted deeper within the body from the surface mount – reducing the back focus distance of each lens to the minimum possible and therefore achieves high resolution all the way to the edge of the image.

3 VIEWFINDER

By automatically adjusting viewfinder magnification to each new lens's focal length, the X-Pro1's advanced hybrid viewfinder is uniquely designed to enable the use of both optical and electronic viewfinders.

1 LENS

The all-glass FUJINON aspherical lens features a super EBC coating, high-quality metal barrel and 1/3-click aperture increments. It's an engineering masterpiece.

BEAUTIFUL SHOTS FROM EVERY ANGLE

Fujifilm's X-Pro1 camera squeezes professional performance into a compact form. It's an object lesson in fusing style and technology

With the X-Pro1, Fujifilm have quite possibly created the ideal compact digital camera. Its visionary X-Trans CMOS sensor revolutionises the pixel layout at the very heart of digital cameras. The unique 6x6 configuration of the sensor mimics the random dispersion of the silver halide particles of camera film, and so breaks the cyclical repetition of pixels that causes *moiré* (the strobing effect seen when fine geometrical detail is pixelated).

Why is this so significant? Because it removes the need for low-pass filters, and no low-pass filters means a resolution comparable to a full frame sensor, but in a compact camera.

Combined with its unrivalled speed and versatility, the X-Pro1 will take your photography to the next level.

LENS FAMILY

Exclusive to the X-Pro1, three new single-focal length lenses offer precise depth-of-field control and open the door to unrivalled *bokeh* (the deliberate blur outside the focal plane).

4

X-PRO1: THE FINE DETAILS IN FOCUS
RRP £1,429.99 (body); lenses £549.99-£599.99
Lens specs: XF 18mmF2 R; XF 35mm F1.4 R; XF 60mm F2.4 Macro.
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WIRED INSIDER

EVENTS, NEW PRODUCTS, PROMOTIONS AND COMPETITIONS TO LIVE THE WIRED LIFE

COMPILED BY TILLY BULL

1 REWIRED STATE HELPS OUT

At a very special hack weekend in April, Refugees United challenged Rewired State's hackers, and Ericsson's funding and tech support, to make it easier for the 100,000 refugees on its platform to reconnect, and for the 43 million refugees worldwide to sign up. You can see the full results at *hacks.rewiredstate.org/events/refunited*

2 BELL & ROSS BR01 HORIZON

Inspired by the cockpit clocks of 70s aeroplanes, the Bell & Ross BR01 Horizon is equipped with an attitude indicator to monitor the aircraft's position relative to the horizon (grey representing sky and black representing Earth), an altimeter indicator and turn co-ordinator showing flight symmetry, and, of course, a trusty compass to navigate with. *bellross.com*

3 SAMSUNG GALAXY NOTE

The latest to join the Samsung family – the Galaxy Note – has all the benefits of a tablet with the portability of a smartphone. And the new S Pen technology that comes with it eliminates any difficulty in working on documents on the run by making editing them a breeze. There is even a series of apps designed specifically for the S Pen. *samsung.com/uk*

4 VOYAGE D'HERMÈS FRAGRANCE

Hermès designer Philippe Mouquet has created a stylish, travel-friendly limited-edition bottle that cleverly opens at the touch of finger. The woody, fresh, amber scent contained within can be worn by both men and women. The Voyage d'Hermès Limited Edition is exclusively available at Harrods, Selfridges W1 and the Hermès boutiques. *hermes.com*

5 ERICSSON ELECTRIC CHARGING

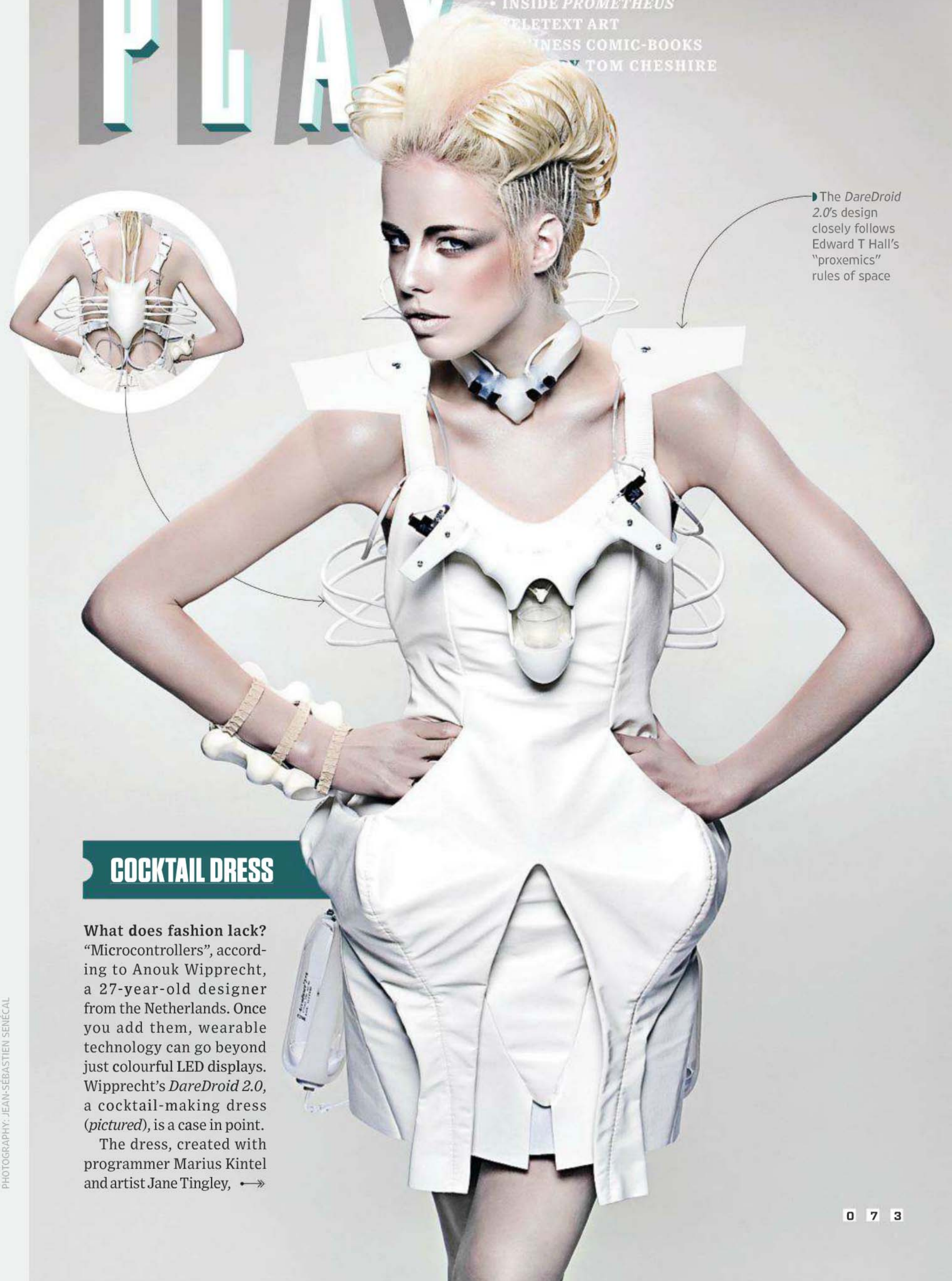
Ericsson is creating a more sustainable future by bringing mobile connectivity to electric cars. Drivers control the charging of their car via their smartphone or tablet while the vehicle is plugged into any ordinary power outlet. The system directs energy costs to the car owner's bill. *ericsson.com/thecompany/press/mediakits/electric_car_charging*

1
Refugees United
Find missing family and friends in 3 easy steps
Do you already have a profile?
What is Refugees United?
5
ELECTRIC
BPL 410
3
12:45
4
2

PHOTOGRAPHY: SUN LEE

PLAY

WIRED CULTURE
THIS MONTH: 07.12
- INSIDE *PROMETHEUS*
- TELETEXT ART
- INESS COMIC-BOOKS
- Y TOM CHESHIRE



The *DareDroid 2.0*'s design closely follows Edward T Hall's "proxemics" rules of space

COCKTAIL DRESS

What does fashion lack? "Microcontrollers", according to Anouk Wipprecht, a 27-year-old designer from the Netherlands. Once you add them, wearable technology can go beyond just colourful LED displays. Wipprecht's *DareDroid 2.0*, a cocktail-making dress (*pictured*), is a case in point.

The dress, created with programmer Marius Kintel and artist Jane Tingley, ⟶

PHOTOGRAPHY: JEAN-SÉBASTIEN SENÉCAL

is equipped with infrared sensors in the neck area that detect people at three stages of proximity: when there is a general crowd, when somebody enters the "personal space of the design" (between 46 and 122 centimetres) and when someone is within "intimate distance" – closer than 46 centimetres. As they approach, the system will serve up a non-alcoholic shot. To get their drink mixed with alcohol (usually gin), the visitor must play a touchscreen-based game of truth or dare. "If you do what the system on the model wants, you are rewarded with a drink," says Wipprecht. "If not, you'll be ignored and left with a shot of nothing." Get too close to the model, and the dress flashes red and shuts down.

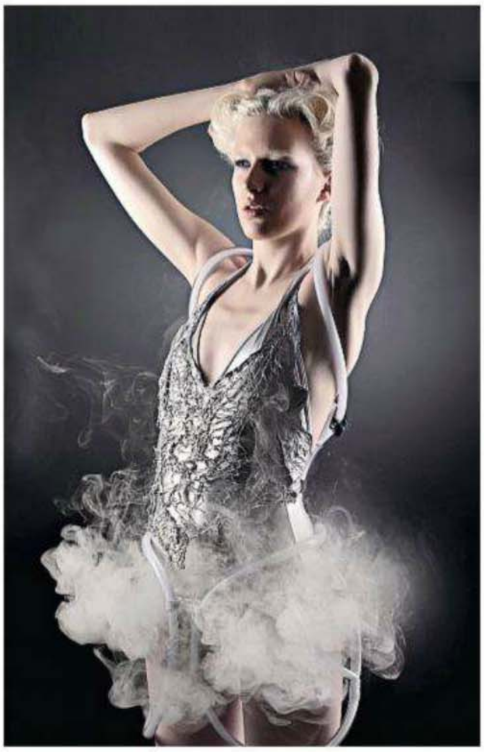
Wipprecht has studied fashion since she was 14, but for the last four years has been interested in "animating" her designs. She taught herself Arduino and uses it to prototype designs, before creating customised circuit boards.

Her newest creation, the battery-driven *Smoke Dress* (*below*), contains miniature smoke machines made by German manufacturer Look Solutions. Blinking LEDs sewn into the dress are designed to attract interest, "but as soon as you approach, it covers itself in smoke – just like an octopus in self-defence." Arduino is the new farthingale. **TC** *anoukwipprecht.nl*

◗ Wipprecht (*above*) will found a wearable-tech lab at Tsingua University, Beijing

◗ The *Smoke Dress* is "technosensual", explains Wipprecht

iPad extra! Download the WIRED app to see a video of Wipprecht's work

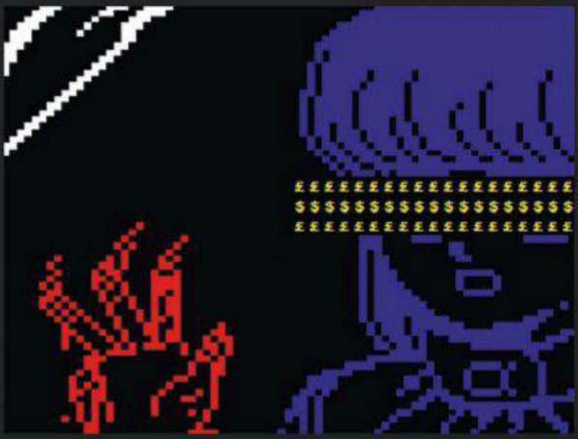


Teletext unplugged

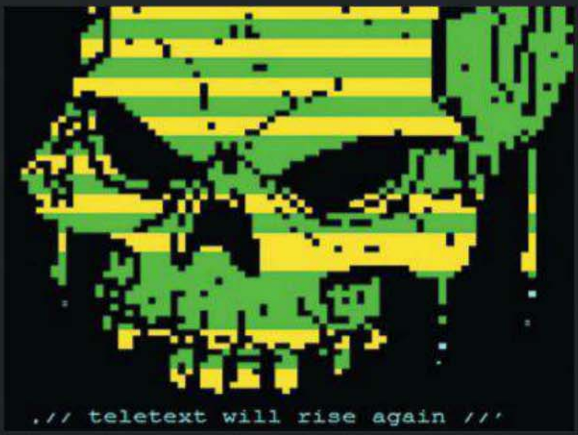
The BBC has switched off this analogue 70s legacy – but its art-led revival is already here

Ceefax was brief, but art is long. Although the BBC will switch off its Teletext service – the last in the UK – this October, FixC, an artists' co-operative in Helsinki, is preserving the medium by organising the world's first international Teletext art festival. "We received some very different approaches to Teletext art: abstract, representative, pop, political and expressive," says Juha van Ingen from FixC (shown here are a selection of the works). "Teletext looks simple to use, but it really isn't."

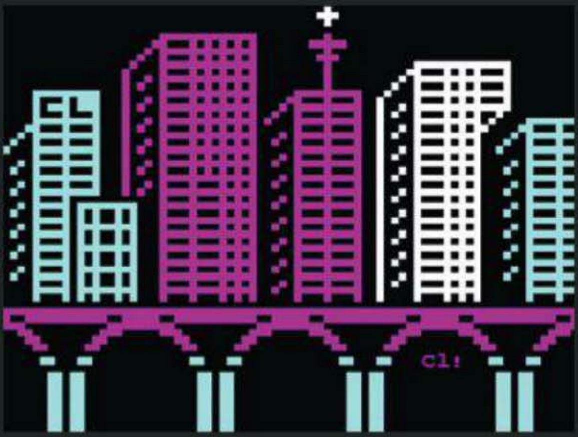
The artworks will be shown on German Teletext in August; they've already featured in the Teletext pages of YLE, the Finnish national broadcaster. "YLE has some 900,000 daily viewers of its Teletext pages and the service remains popular in some other European countries," says van Ingen. "It is surprising that it is disappearing from the UK." Certainly beats watching the Test Card. **TC** *fixc.fi/itaf*



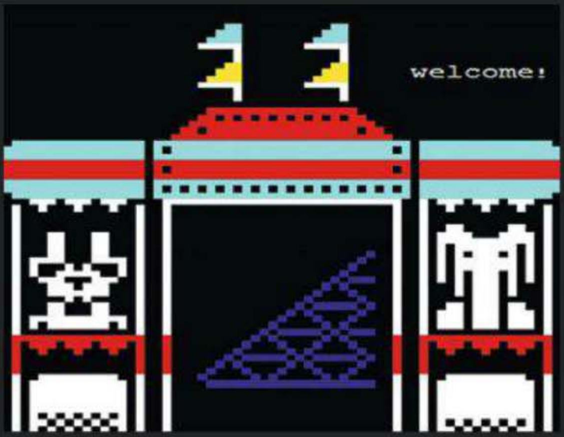
Ashley Anderson, *Help*



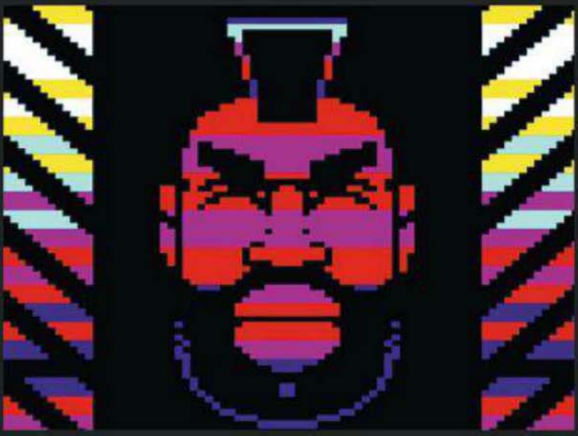
Dave Needham, *Deadmedia XIII*



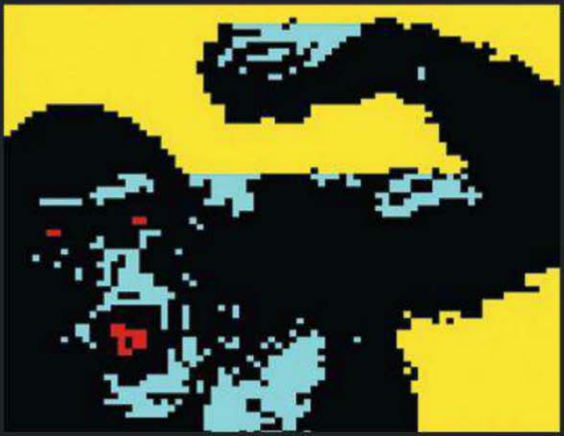
Frederic Cambus, *Tech City*



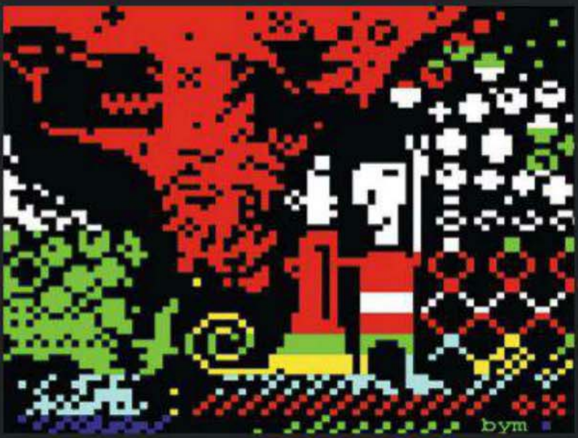
Raquel Meyers, *Untitled*



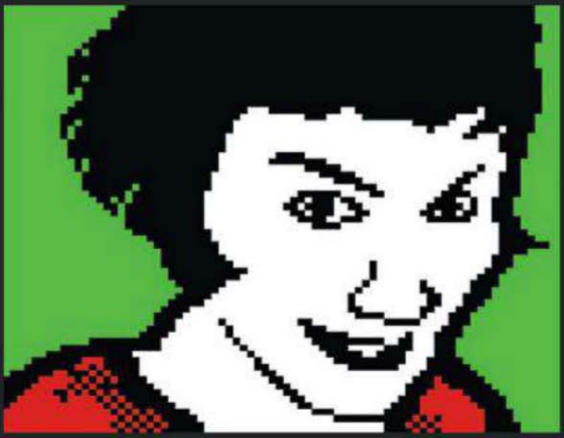
Janne Suni, *Untitled*



Max Capacity, *Untitled*

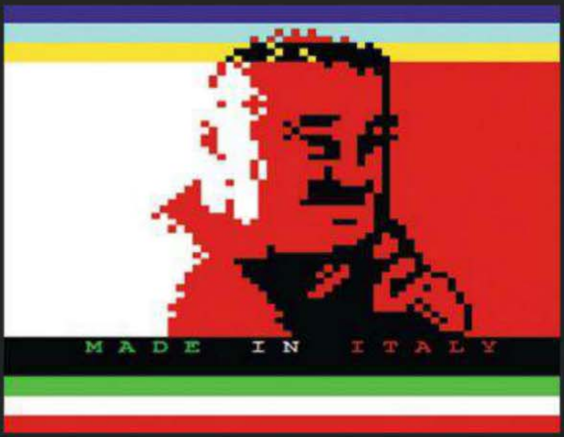


BYM, *Untitled*

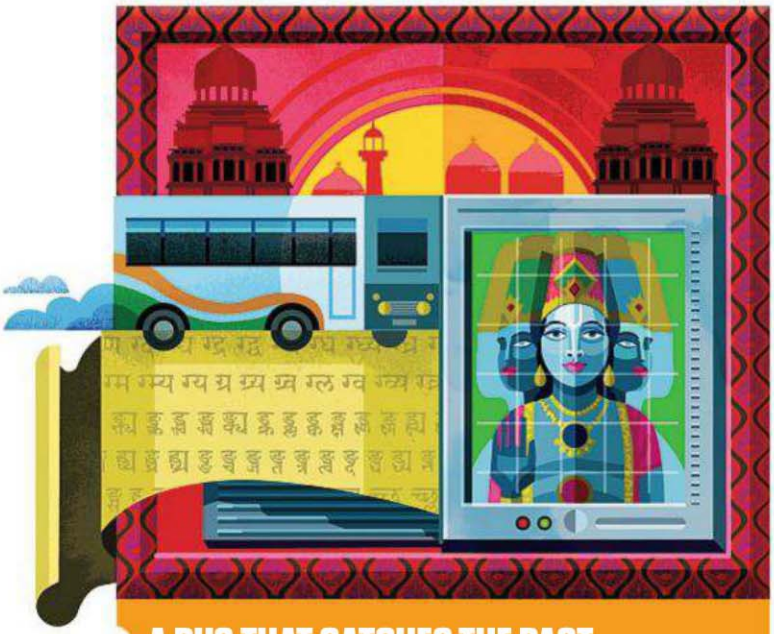


Rich Oglesby, *Untitled*

Dan Farrimond, *At Least I Don't Have to Go to Work*



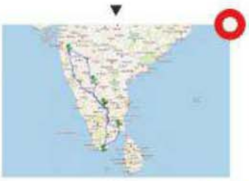
Guillermo Blanco, *Made in Italy*



A BUS THAT CATCHES THE PAST

Rama Budihal is creating digital history on wheels. "In India, we don't care about history, because we have too much of it," says Budihal, a Bangalore-based engineer and inventor. "I want to build recognition of the wealth of treasures we have here." His first stop: digitally preserving the roughly five million ancient manuscripts across the country, using a bus kitted out with a scanner, GPS and navigation, and systems that connect a network of historians and scholars in Delhi and Bangalore. Since 2007, the team has scanned more than a million scripts. The data is annotated and stored in the National Manuscripts Data Centre.

Now, the bus is moving on to monuments. "I want to preserve the tangible heritage of India too," says Budihal. His first project is to scan a 3D version of the ancient city of Hampi, a Unesco World Heritage Site. Budihal's team is patenting a range of immersive tools – a humanoid telepresence robot guide, a mechanical arm and a digital "time machine" that takes you back to an approximate reality 500 years ago. "You can create an avatar and experience Hampi from anywhere," says Budihal. "I am dreaming of something very big." MV
indiainnovationlabs.com



- The HQ is a heavily modified touring bus
- The team's route through southern India
- The object scanner (blue area) inside the bus
- Karnataka, where many documents are stored
- A 300-year-old text made from palm leaves
- Its digital rendering, cleaned and enhanced

Creative outlaws

A collective of web artists aims to disrupt the art elite

Think the art world is snobby? So does Lucky PDF, an artists' collective from south London. Their latest project, "The School of Global Art", is a semi-fictional roving art school that exists online and at events, and professes to award BA, MA and PhD qualifications. The introductory video on schoolofglobalart.org might suggest otherwise. Participants wishing to become artists are asked several questions, which include,

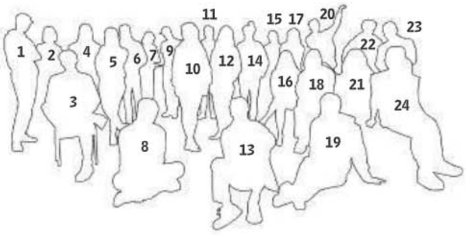
PHOTOGRAPHY: NICK WILSON. ILLUSTRATION: ROBERT BALL

“Have you ever slept with someone in the art profession?”, and if so, “Have you ever had a conversation with a major European curator?” The project reflects the members’ claim that art has been subsumed by the web to form a far more uniform culture. “Art has become much more like real life,” says member Ollie Hogan, 25.

Lucky PDF operates at this cross-section, where real life meets the virtual, bridging the time lag that exists between museum and the digital realm. The members of the group, which also includes James Early and John Hill, both 26, and Yuri Pattison, 25, came together “to find new ways of funding, making and exhibiting art within a large network of artists and collaborators,” according to Hill. Merging the crowdsourced mentality of the web with the large-scale production infrastructure of television, the group invites creators from various disciplines to produce tongue-in-cheek live, online television-style programmes and parties with an aesthetic similar to that of Chris Morris’s satirical show *Brass Eye*. They call it “post-internet” art – the idea that art online is no longer an elite field, but a mass medium.

Collaborators include Chloe Simms, of *The Only Way is Essex* (to bring “outsiders into the art world”, claim the group), and New York-based multimedia artist Cory Arcangel. Treating the art world mean is keeping it keen: Lucky PDF has featured at Frieze, Tate Modern, the Barbican and the BFI. School’s out. **Omar Kholeif** *schoolofglobalart.org*

iPad extra!
Download the WIRED app for the School of Global Art prospectus



SCHOOL OF GLOBAL ART CLASS OF TOMORROW

1. Ed Fornieles, artist **2.** Grace Schofield, gallerist **3. John Hill**, educationalist **4.** Amy Woodward, artist **5.** Daisy Hogan, artist **6.** Felix Nash, artist and writer **7.** Rebecca Holborn, curator **8. Ollie Hogan**, DJ and blogger **9.** Daniel Swan, artist and architect **10.** Susanna Davies-Crook, artist and journalist **11.** Mitchell Bridges, artist **12.** Alice Early, fashion designer **13. Yuri Pattison**, artist **14.** Suren Seneviratne, producer and DJ **15.** Marta Herman, museum curator **16.** Holly Hayward, sculptor **17.** Alice Martin, philosopher activist **18.** Harry Sanderson, artist **19. James Early**, feminist theorist **20.** Louis Eastwood, poet **21.** Märta Terne, PR **22.** Jon Nash, artist **23.** David Rudnick, graphic designer **24.** Philip Li, ceramicist and performer

It's all in the twist

The Rubik's Cube was one of the best-selling toys ever. Revisit the classic, then try solving its mutant offspring

1. BRAIN-STRING (ADVANCED)

Perfect for: Getting idle hands tied up in Gordian knots. **WIRED twist:** It's the spitting image of a microbe. Also, 12 strings and 24 knobs ensure that one wrong move will result in a tangled snarl. *£12*

2. DAYAN GEM CUBE III

Perfect for: Puzzling with flair – you can decorate it yourself. **WIRED twist:** Known in the puzzle biz as a "helicopter dodecahedron", this 12-sided figure with spinning faces may be the *Airwolf* of geometric puzzles. *$42*

3. V-CUBE 7 ILLUSION

Perfect for: Channelling the spirit of 2 Tone. **WIRED twist:** First, this bulging black-and-white cube hits you with optical illusions. Then it melts your brain with a giddy 49 squares per side. *£34.99*

4. ORIGINAL RUBIK'S CUBE

Perfect for: Busying your brain while you watch 80s cartoons. **WIRED twist:** Pit your skills against others at the World Cube Association. The youngest speed-champ? Three-year-old Shengzhi Gao at 1:02:30. *£9.99*

5. BRAIN TWIST

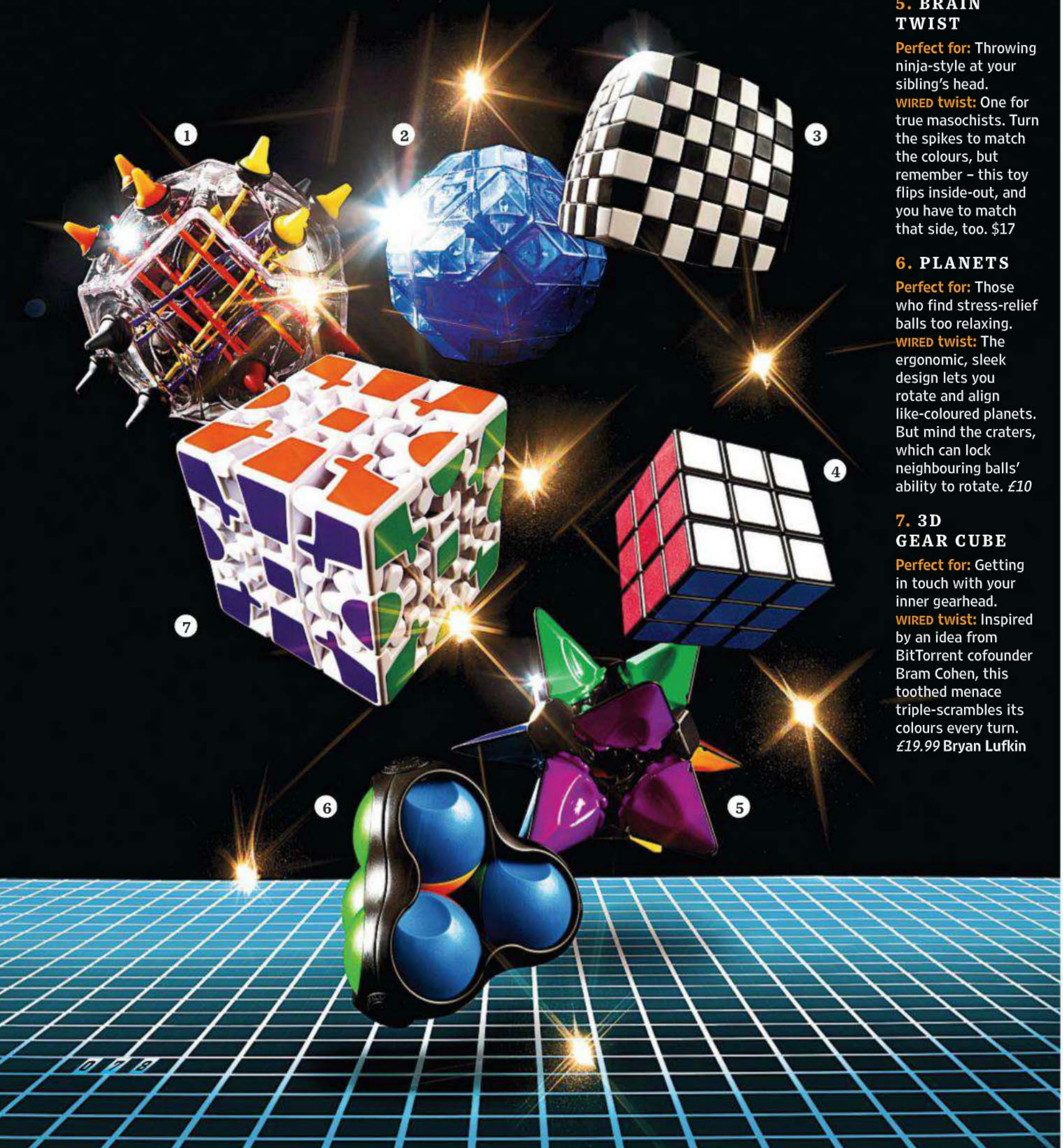
Perfect for: Throwing ninja-style at your sibling's head. **WIRED twist:** One for true masochists. Turn the spikes to match the colours, but remember – this toy flips inside-out, and you have to match that side, too. $17

6. PLANETS

Perfect for: Those who find stress-relief balls too relaxing. **WIRED twist:** The ergonomic, sleek design lets you rotate and align like-coloured planets. But mind the craters, which can lock neighbouring balls' ability to rotate. *£10*

7. 3D GEAR CUBE

Perfect for: Getting in touch with your inner gearhead. **WIRED twist:** Inspired by an idea from BitTorrent cofounder Bram Cohen, this toothed menace triple-scrambles its colours every turn. *£19.99* **Bryan Lufkin**



PHOTOGRAPHY: DAN FORBES. UK-PRICED PUZZLES AVAILABLE AT AMAZON.CO.UK. US-PRICED PUZZLES, WE COULDN'T SOLVE...

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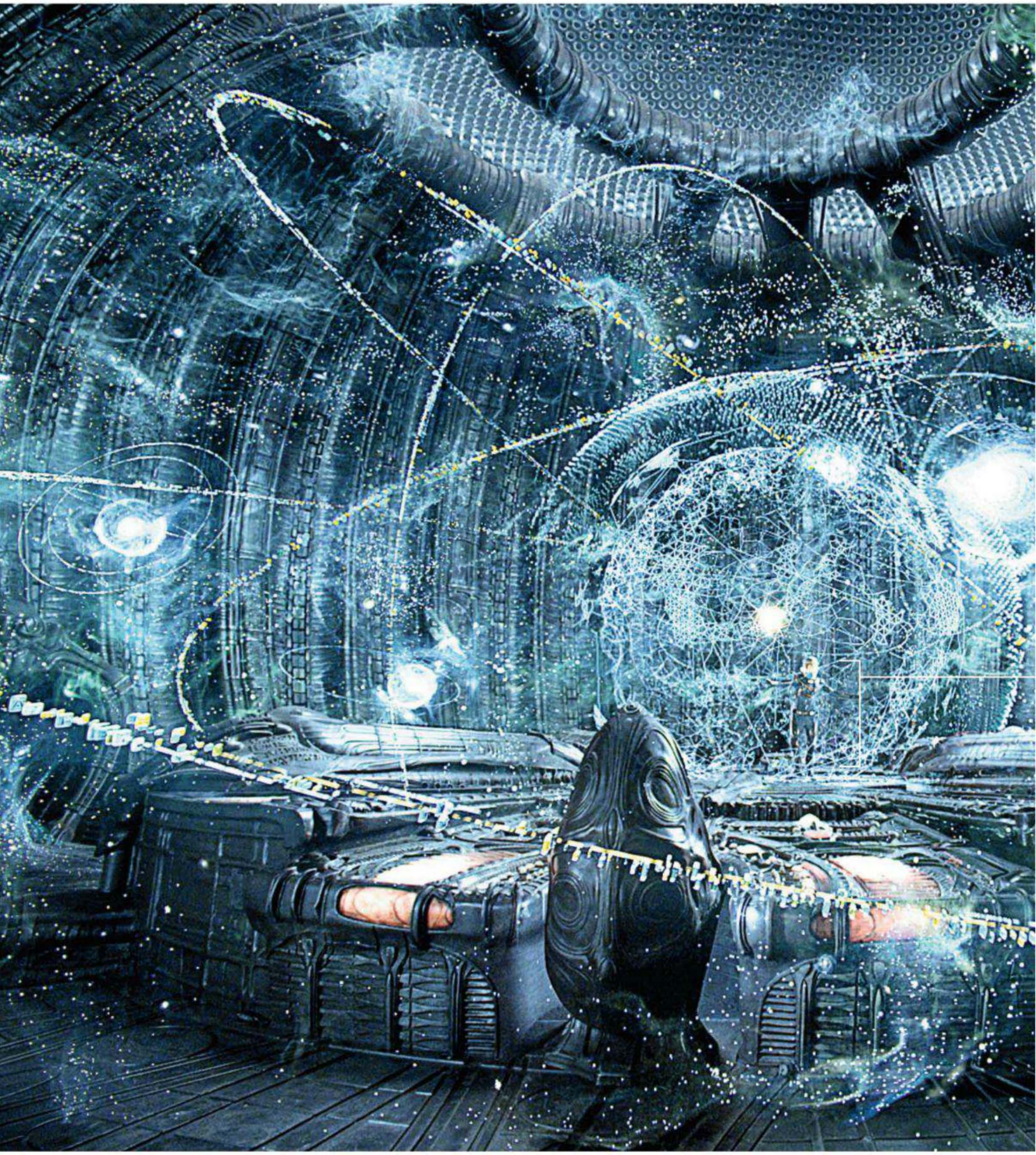


Scream if you want: it's space

Be prepared for body-horror encounters of the first kind in the upcoming Alien *prequel*

The summer blockbuster *Prometheus* brings Ridley Scott back to the dark future of his 1979 hit *Alien*. On set, Scott revealed that the secret of his earlier film's visceral special effects was: actual viscera.

"They went to a meat market and bought the gizzards and innards of cows," Arthur Max, *Prometheus*'s production designer, recalls. "That's how he got the membrane to pulse inside the alien egg. It was Ridley, under the set, manipulating it."

CGI has transformed sci-fi cinema since *Alien* terrified audiences. But in an age of *Avatar*s and *Phantom Menace*s, Scott still insists on giving his cast something to get their teeth into. Max, now 66, has been working with him on commercials and then, from *Gladiator*, on Scott's epic film visions. "Ridley has said to me, on every film we've done, 'These sets are great, but they're really not big enough'. They are never big enough! We build fragments – huge fragments – so the actors are

⟶

The android, David, activates an alien star chart

A crew member stands beneath a temple sculpture

interacting with physical space, and then the beyond-ness is extended digitally."

Max and Scott then created digital 3D models of each potential set, to see where the physical set had to end and the virtual begin. They also constructed miniature replicas, arranging and re-arranging them on a giant table. By time the film wrapped, the art department was full of these models.

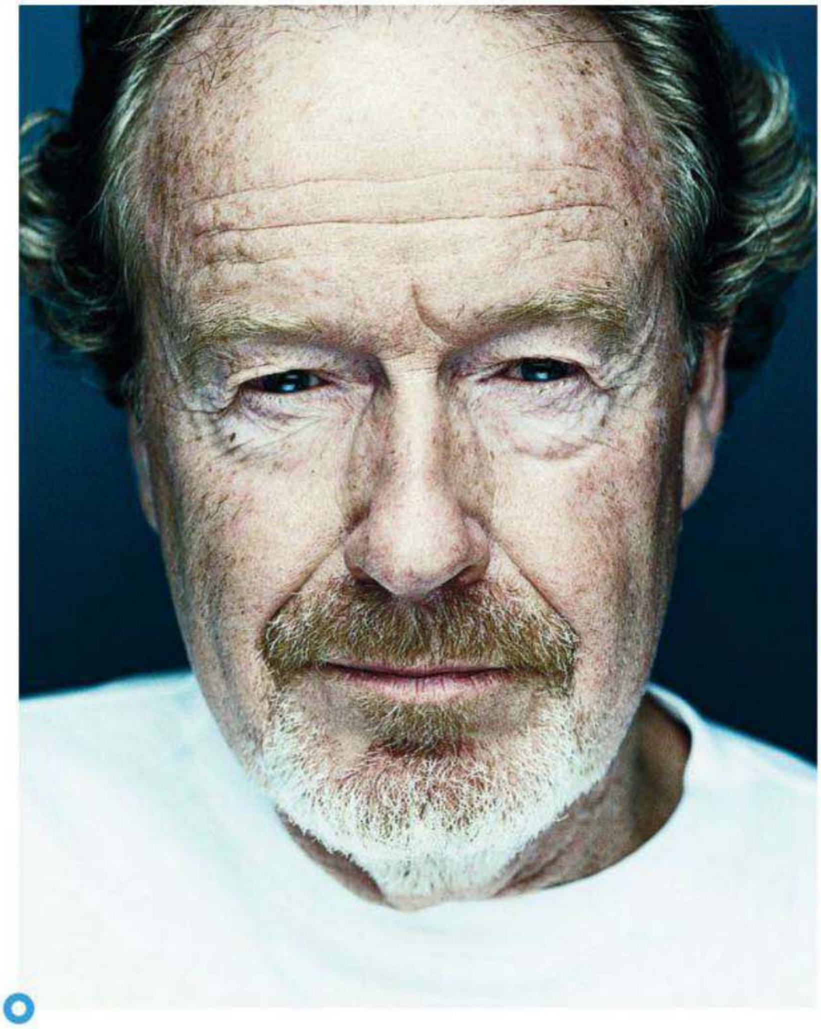
Prometheus's quest for creative elbow room took the crew to Pinewood Studios. At 5,480 square metres, the Albert R Broccoli 007 stage is the largest of its kind in Europe. Even then, space was an issue. So Max opened up the 25-metre studio doors and built an extra 45 metres of set through them.

And, when the sets were broken down and the graphics artists got to work, every effort was made to make the joins between set and CGI invisible: for example, the team took samples of local stone during location shooting in Iceland, to better match their graphical textures to the rock.

"[CGI] has been added, but you don't smell it, the way you do on other films," say Max. "There's enough traditional film-making to seduce the audience, so they feel it's a real place and it's really happening." **Daniel Nye Griffiths** Prometheus *is in cinemas June 1. prometheus-movie.co.uk*

RIDLEY SCOTT: DIRECTOR'S CUT

WIRED spoke to Ridley Scott in London last November, during post-production on *Prometheus*. Here's what he revealed.



PHOTOGRAPHY: CORBIS; 20TH CENTURY FOX FILM CORP

When you made the original *Alien* film there were no CGI effects available. You created full sets, and it was very claustrophobic. What was the balance between physical sets and CGI on *Prometheus*?
I got a bit of a learning curve on *Kingdom of Heaven*, when I started to get enthusiastic about what you could do digitally, and that kind of whetted my appetite. So while I may have a certain amount of substantial set building, I can always complete it. Like on *Gladiator*, where I only built 40 per cent of the Coliseum – the rest was put in digitally. It's shocking what you can do, so I am a full enthusiast for digital and green screen and everything else, but I really hate having to have actors acting away in front of a green screen and have somebody saying: "The monsters are coming, what are you going to do?" and all that shit. I still believe in putting a proscenium around the actors to help them as much as possible.

How have you found shooting in 3D?
The 3D world allows you to engage even more with a film because you're somehow drawn into the landscape or the universe of that scene. Even when it's two people talking at a table, you feel like you're a third party. I've tried to analyse this and I think what we don't realise is that we see in 3D anyway. You've got two cameras, two eyes. Your brain has got so used to that, that it's no longer spectacular until you then see it and re-identify it on screen. You put on glasses and you go, "Oh my God, that's spectacular," but actually it's what you see anyway.

If the original *Alien* can be considered a B-movie, would you say *Prometheus* is more an epic?
It certainly is budget-wise. But I think *Alien* itself, although it had a low-budget, somehow it came out as epic, and this one is certainly epic. I mean, we went pretty big in terms of landscape. What you saw with the first *Alien*, it felt pretty big, and they were all just straightforward models of landscapes and what I call "The Big Croissant" – the alien spaceship. **Ian Nathan**

Ridley Scott (*above*) has returned to the *Alien* universe 33 years after making his first now-iconic science-fiction masterpiece

Right: Scott discusses a scene with Charlize Theron (playing corporate suit Meredith Vickers) on the physical set of *Prometheus*

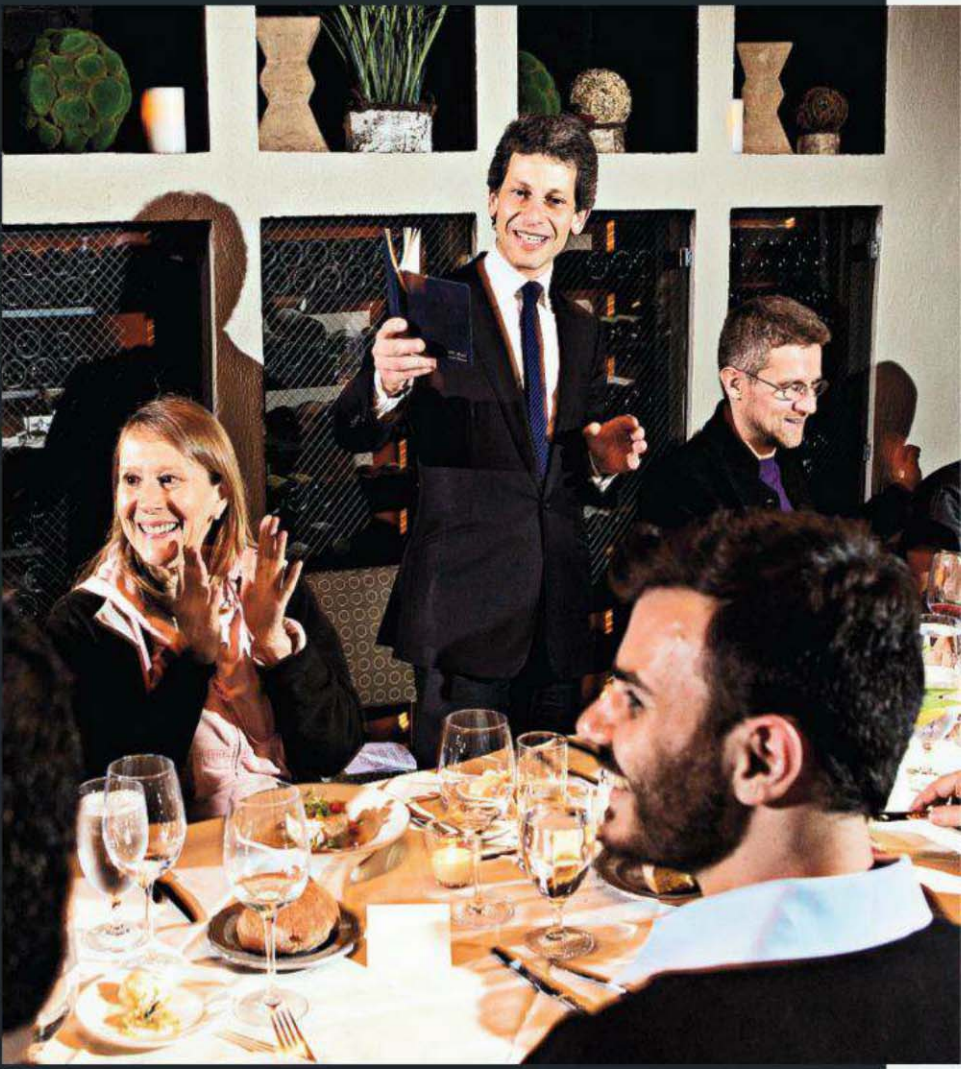
Carlo Ratti, MIT SENSEable City Lab

Michael Norton, Harvard business professor; Daniel Heaf, BBC Worldwide

WIRED INSIDER

EVENTS, NEW PRODUCTS, PROMOTIONS AND COMPETITIONS TO LIVE THE WIRED LIFE

BOSTON DINNER PARTY



WIRED editor David Rowan welcomes guests to the inaugural Smart List dinner

For our February issue we approached 50 people we admire to ask them a simple question: if you could have dinner with an emerging figure in your field, who would it be? The results, which we called the Smart List, were a serendipitous delight. In April, to celebrate the idea, WIRED's editor David Rowan hosted a dinner in Boston with Telefónica to celebrate the nominators and nominees. Its success ensures we will be hosting further Smart List dinners in San Francisco and London in the coming months. Watch this space.

PHOTOGRAPHY: BRYCE VICKMARK

Alex Pentland, MIT; June Cohen, TED; Nicholas Christakis, Harvard doctor and author

Nigel Jacobs, Boston Mayor's office; Jose Gomez Marquez, MIT

Juan Enriquez, life scientist and investor

Ramesh Raskar, MIT Media Lab; Assaf Biderman, MIT SENSEable City Lab

Craig Venter, genetics pioneer; David G Rand, Harvard scientist

Gonzalo Martin, Telefónica; Esther Dyson, investor

Elisabet de los Pinos, Aura Biosciences

EXPANSIVE THINKING

WIRED and City University London are offering one reader a full scholarship worth up to £20,000 for a Masters in Innovation, Creativity and Leadership (MICL)

The skills we need to excel in the modern workspace evolve constantly. Never mind spreadsheets or databases, if you really want to succeed you have to be a genius at working with people, generating ideas, approaching problems constructively and with creativity.

That's precisely what sparked City to create their Masters in Innovation, Creativity and Leadership (MICL). It's a one- or two-year course that gives you the skills you need to turn ideas into action, tap creative talent and develop skills that will make you invaluable.

The scholarship will go to the winner of the Healthy Mind, Healthy Community competition. This year's brief centres around mental health and its impact on society and individuals alike. The more obvious benefits include longevity, physical health, productivity, creativity, contentedness and achievement. The annual wider economic cost of mental health problems in the UK is £110 billion – a figure that is set to double over the next 20 years – but could be reduced by a greater focus on prevention.

So the question this year is as follows: what can new technologies and innovative ways of thinking do to enhance mental health and positive well-being; for example through relaxation, creativity or purposeful community activity? And how can they help to promote sustainable, connected and socially-inclusive communities? Your contribution could involve innovations in anything from education or communication to political, tech or business-related themes.

To enter, submit a proposal of up to 750 words (supported, if you wish, by video, illustration or a presentation). Send your proposal by email before July 11, 2012 to *wired-scholarship@soi.city.ac.uk.*

The prize is worth £15,000 to UK/EU winners, £20,000 to other international students. This covers only fees, not subsistence, living arrangements or travel. For full terms and conditions, visit *creativity.city.ac.uk/wired-scholarship*

> 'I'M HALFWAY THROUGH THE COURSE BUT IT HAS ALREADY CHANGED MY THINKING. THE MICL HAS HELPED ME TO DISCOVER MY INNER CHILD, MY OWN CREATIVITY, AND PROVIDED ME WITH A TOOLBOX – NOT A MANUAL – TO USE AND FURTHER DEVELOP IN LEADING CREATIVITY AND INNOVATION.'
>
> **(LAST YEAR'S WINNER, SZABI STEINER)**

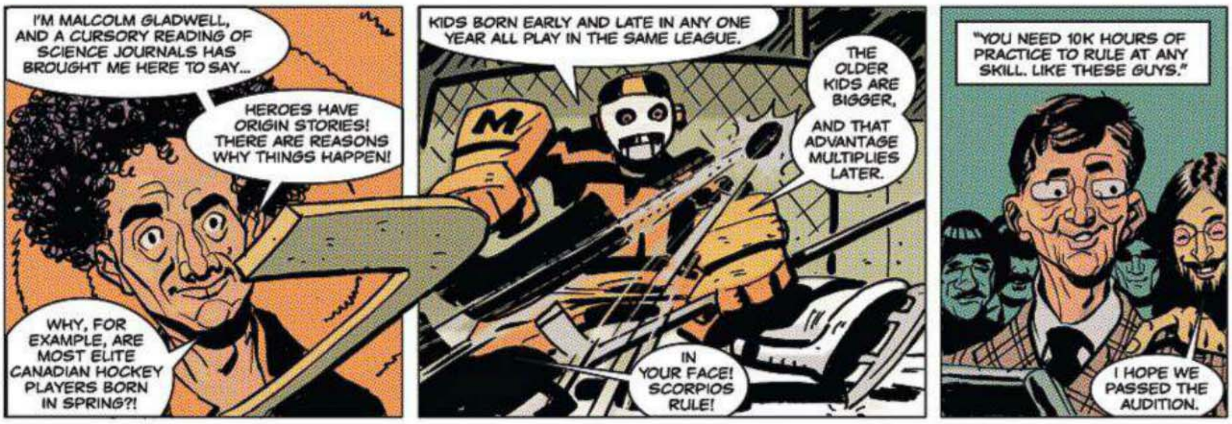
ILLUSTRATION: PESKIMO

C-suite comics

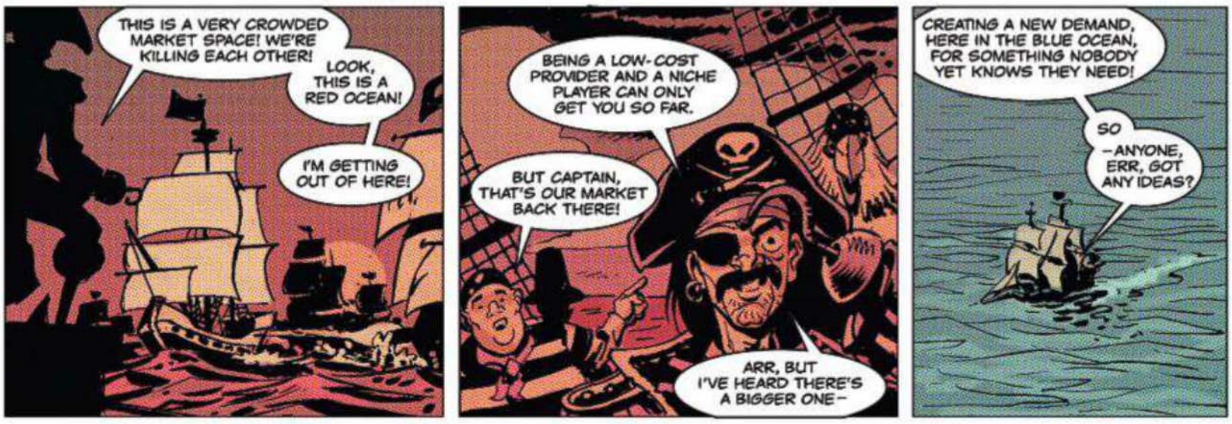
Business books can be all, well, business. WIRED adds some action-hero kapow!

Robert Cialdini's best-selling business book, *Influence: The Psychology of Persuasion,* is being turned into a graphic novel; as has Tom Hopkins's *How to Master the Art of Selling*. Even *The Long Tail* – by WIRED US editor in chief Chris Anderson – has had the comic-book treatment. This set WIRED's trend-sense tingling – so we asked British-based DC Comics writer-and-artist dynamic duo, Paul Cornell and James Hodgkins, to activate their special abilities and make some other seminal business tomes a little more... super. Gladwell, away! **TC** *paulcornell.com*

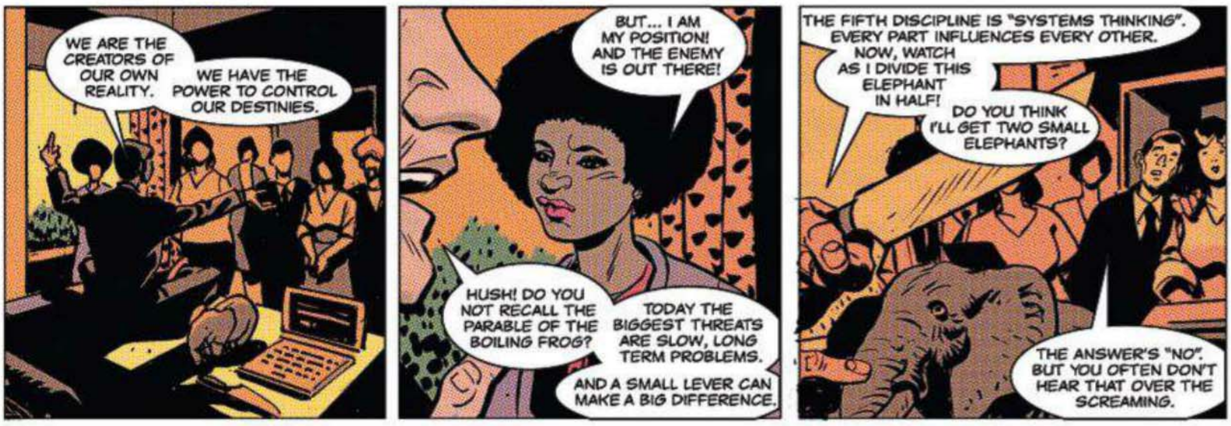
MALCOLM GLADWELL, *OUTLIERS: THE STORY OF SUCCESS*


I'M MALCOLM GLADWELL, AND A CURSORY READING OF SCIENCE JOURNALS HAS BROUGHT ME HERE TO SAY...
HEROES HAVE ORIGIN STORIES! THERE ARE REASONS WHY THINGS HAPPEN!
WHY, FOR EXAMPLE, ARE MOST ELITE CANADIAN HOCKEY PLAYERS BORN IN SPRING?!
KIDS BORN EARLY AND LATE IN ANY ONE YEAR ALL PLAY IN THE SAME LEAGUE.
THE OLDER KIDS ARE BIGGER,
AND THAT ADVANTAGE MULTIPLIES LATER.
M
IN YOUR FACE! SCORPIOS RULE!
"YOU NEED 10K HOURS OF PRACTICE TO RULE AT ANY SKILL. LIKE THESE GUYS."
I HOPE WE PASSED THE AUDITION.

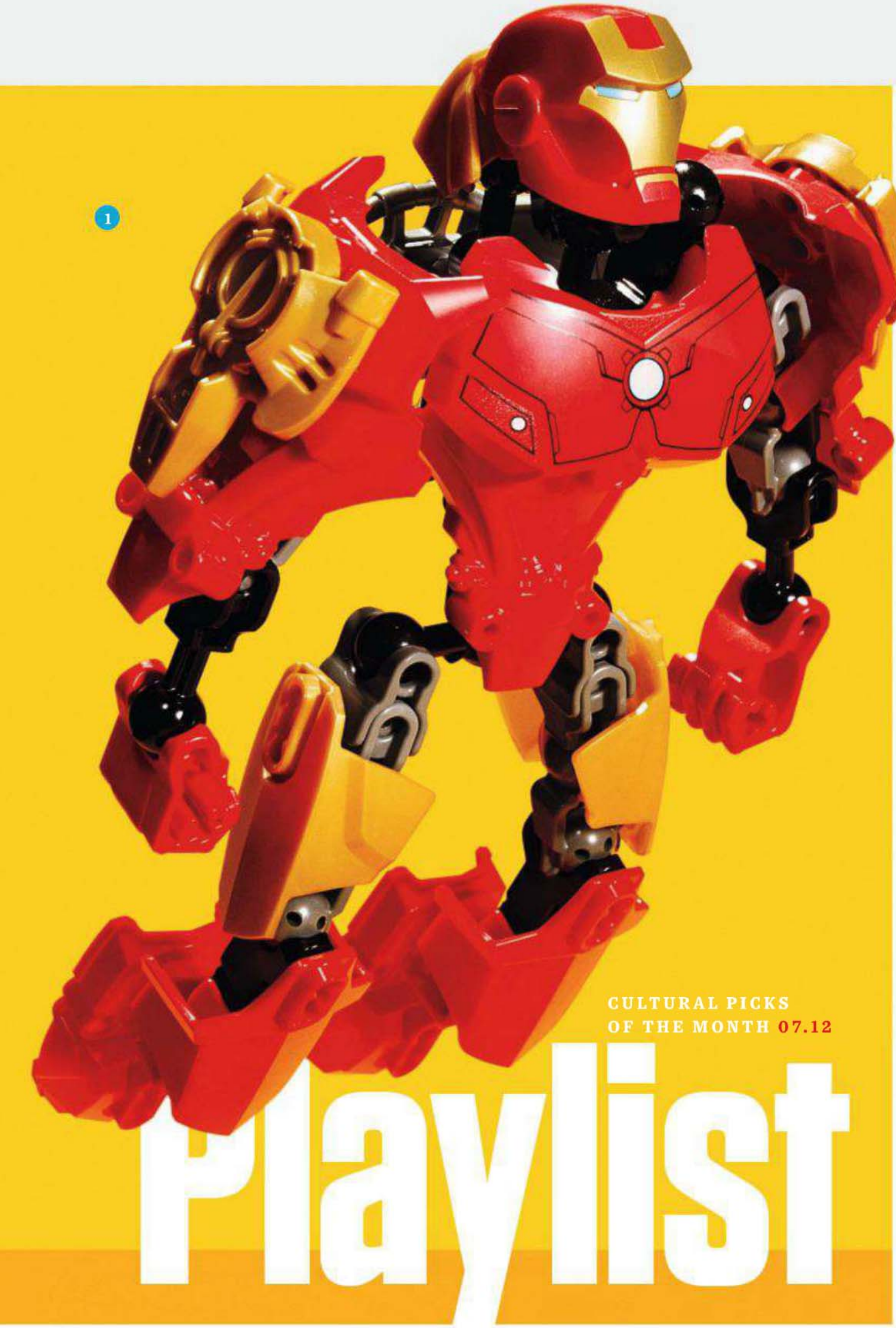
W CHAN KIM AND RENÉE MAUBORGNE, *BLUE OCEAN STATEGY: HOW TO CREATE UNCONTESTED MARKET SPACE AND MAKE THE COMPETITION IRRELEVANT*


THIS IS A VERY CROWDED MARKET SPACE! WE'RE KILLING EACH OTHER!
LOOK, THIS IS A RED OCEAN!
I'M GETTING OUT OF HERE!
BEING A LOW-COST PROVIDER AND A NICHE PLAYER CAN ONLY GET YOU SO FAR.
BUT CAPTAIN, THAT'S OUR MARKET BACK THERE!
ARR, BUT I'VE HEARD THERE'S A BIGGER ONE–
CREATING A NEW DEMAND, HERE IN THE BLUE OCEAN, FOR SOMETHING NOBODY YET KNOWS THEY NEED!
SO –ANYONE, ERR, GOT ANY IDEAS?

PETER SENGE, *THE FIFTH DISCIPLINE: THE ART AND PRACTICE OF THE LEARNING ORGANIZATION*


WE ARE THE CREATORS OF OUR OWN REALITY.
WE HAVE THE POWER TO CONTROL OUR DESTINIES.
BUT... I AM MY POSITION! AND THE ENEMY IS OUT THERE!
HUSH! DO YOU NOT RECALL THE PARABLE OF THE BOILING FROG?
TODAY THE BIGGEST THREATS ARE SLOW, LONG TERM PROBLEMS.
AND A SMALL LEVER CAN MAKE A BIG DIFFERENCE.
THE FIFTH DISCIPLINE IS "SYSTEMS THINKING". EVERY PART INFLUENCES EVERY OTHER.
NOW, WATCH AS I DIVIDE THIS ELEPHANT IN HALF!
DO YOU THINK I'LL GET TWO SMALL ELEPHANTS?
THE ANSWER'S "NO". BUT YOU OFTEN DON'T HEAR THAT OVER THE SCREAMING.

1



CULTURAL PICKS OF THE MONTH 07.12

Playlist

1 IRON MAN MEETS LEGO

He's not cast from iron, but Lego's depiction of Stark Industries' finest still looks the part. Tying in with May's release of *The Avengers*, Iron Man's teammates the Hulk and Captain America are also available. *£10.99 marvelsuperheroes.lego.com*

2 CULTURE DOCKING

Goodbye, bland, utilitarian iPad docks: ex-MIT Media Labs designer Scott Eaton has a more voluptuous solution. His *Venus of Cupertino* is cast in marble resin from a 3D-printed mould. She charges as she reads. *£200 scott-eaton.com*

3 YOKO ON SHOW

From June 19 to September 9, London's Serpentine Gallery is hosting "To the Light", a major exhibition of Yoko Ono's work. The focus of the show is SMILE, a project to create a collection of smiley portraits. *serpentinegallery.org*

4 PIXEL PERFECT

Surely inspired by *Jenga*, the PixelTable comprises 441 sticks of bamboo stacked in a half-metre cube, and doubles up as a storage device. Push an item into one side and a shelf will appear on the opposite. *€895, studiointussen.nl*

5 THE MOON, MAPPED

Your lunar conquest starts here: this globe depicts the surface of the Moon using 15,000 images from Nasa's Lunar Reconnaissance Orbiter. Included among its listed locations of interest are the Apollo landing sites. *$99.95 shopatsky.com*

PHOTOGRAPHY: SUN LEE. WORDS: DAN SMITH

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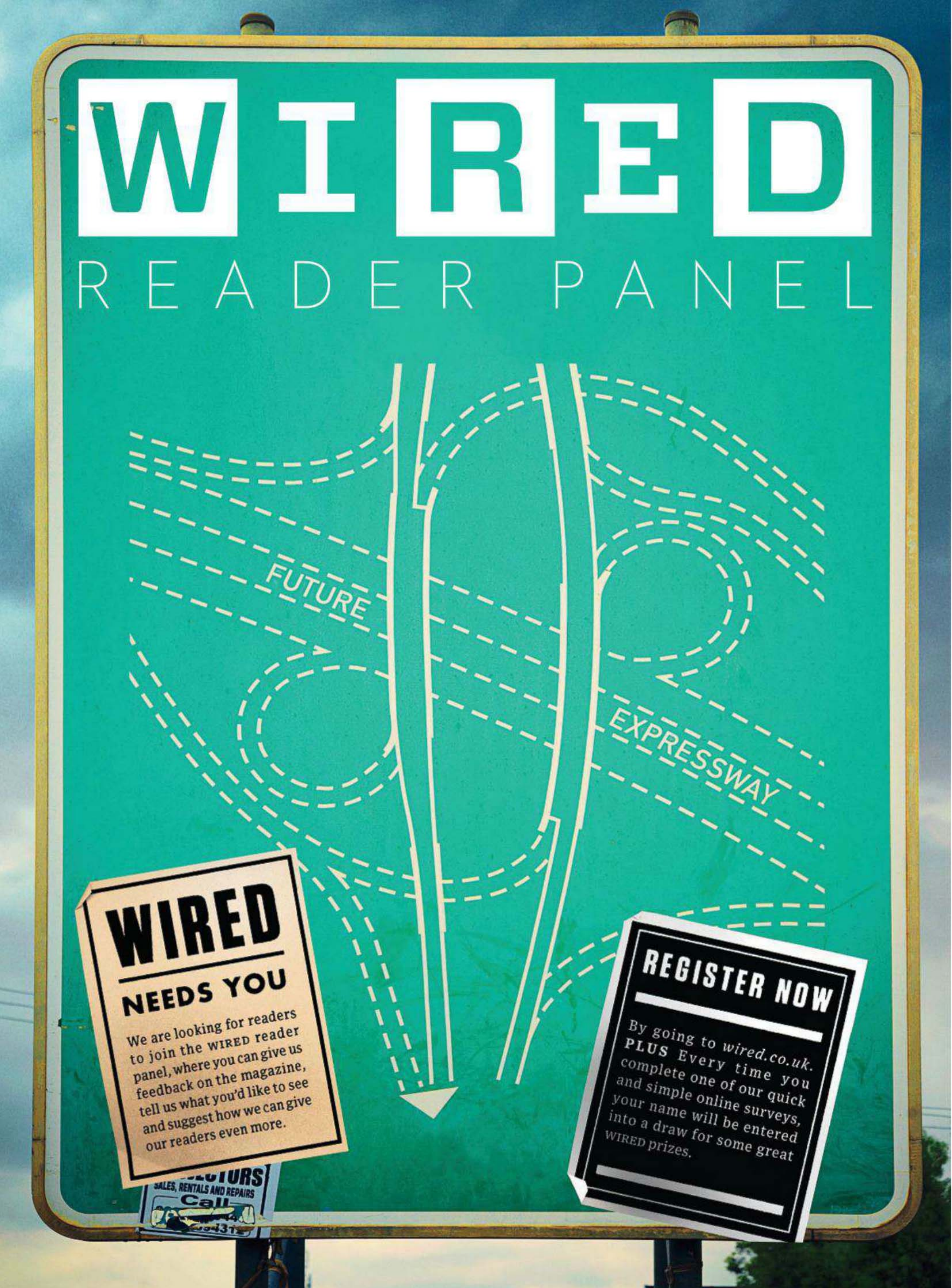

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READER PANEL

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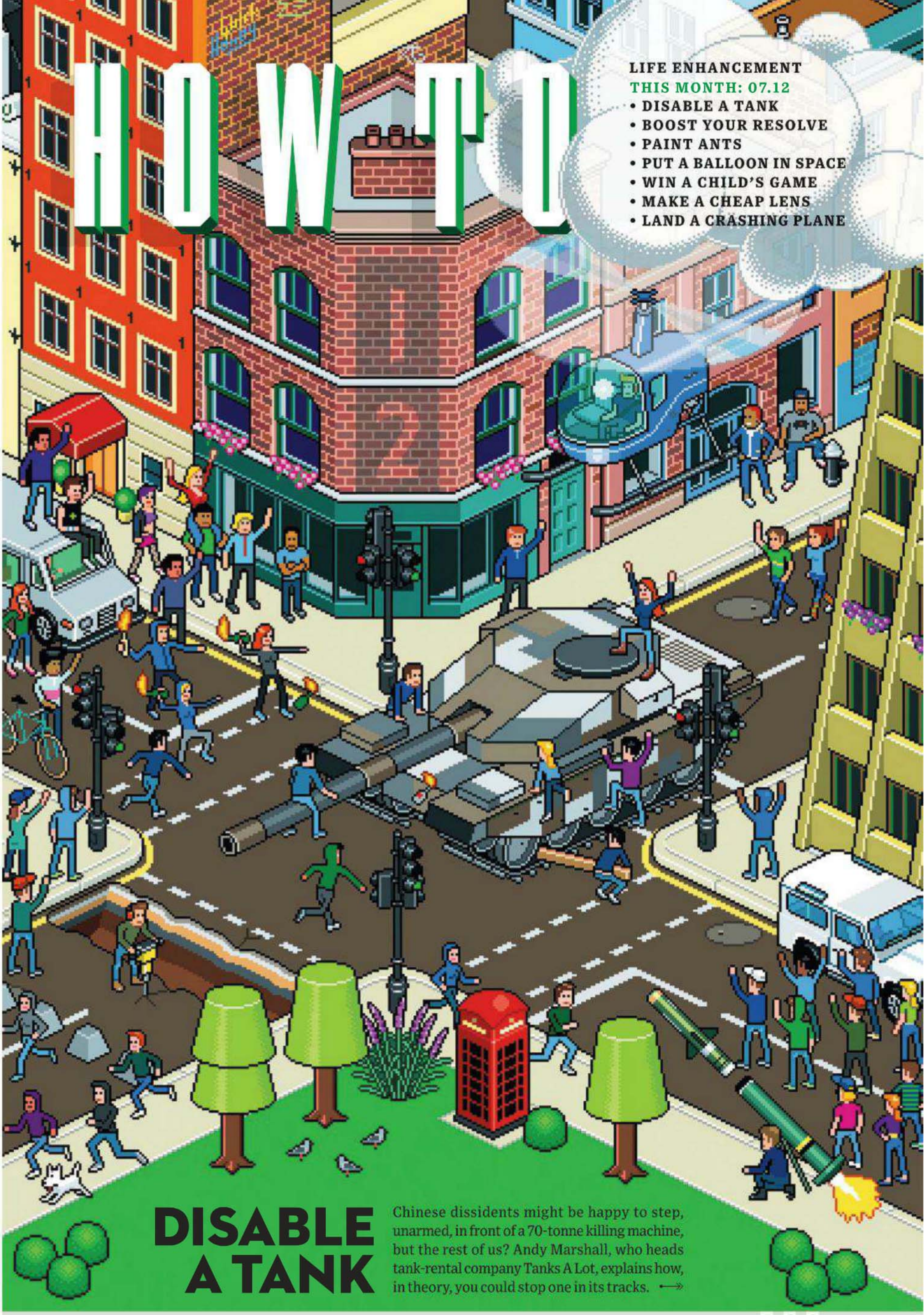
HOW TO



LIFE ENHANCEMENT
THIS MONTH: 07.12

- DISABLE A TANK
- BOOST YOUR RESOLVE
- PAINT ANTS
- PUT A BALLOON IN SPACE
- WIN A CHILD'S GAME
- MAKE A CHEAP LENS
- LAND A CRASHING PLANE

DISABLE A TANK

Chinese dissidents might be happy to step, unarmed, in front of a 70-tonne killing machine, but the rest of us? Andy Marshall, who heads tank-rental company Tanks A Lot, explains how, in theory, you could stop one in its tracks. ⟶

ILLUSTRATION: QUICK HONEY

HOW TO...
DISABLE A TANK

FIREBOMB IT

Home-made breakable-glass missiles have been used effectively against tanks in conflict since the Spanish Civil War. So what – hypothetically – if you find yourself facing a hostile enemy? "Mix petrol and oils in a bottle and plug with a fuel-soaked cloth," says Marshall. "Light the wick; lob the bottle at the air intakes." Not advised for non-war situations, obviously.

STOP IT IN ITS TRACKS

Like a shark, a tank is at its most efficient and powerful when it is on the move. If you can halt its progress, you take away a lot of its power. Damaging its tracks is probably the easiest way to disable it. "A railway sleeper wedged between the wheels and the track will do some serious damage," explains Marshall. "And it might even throw the track off."

SHOOT AT IT

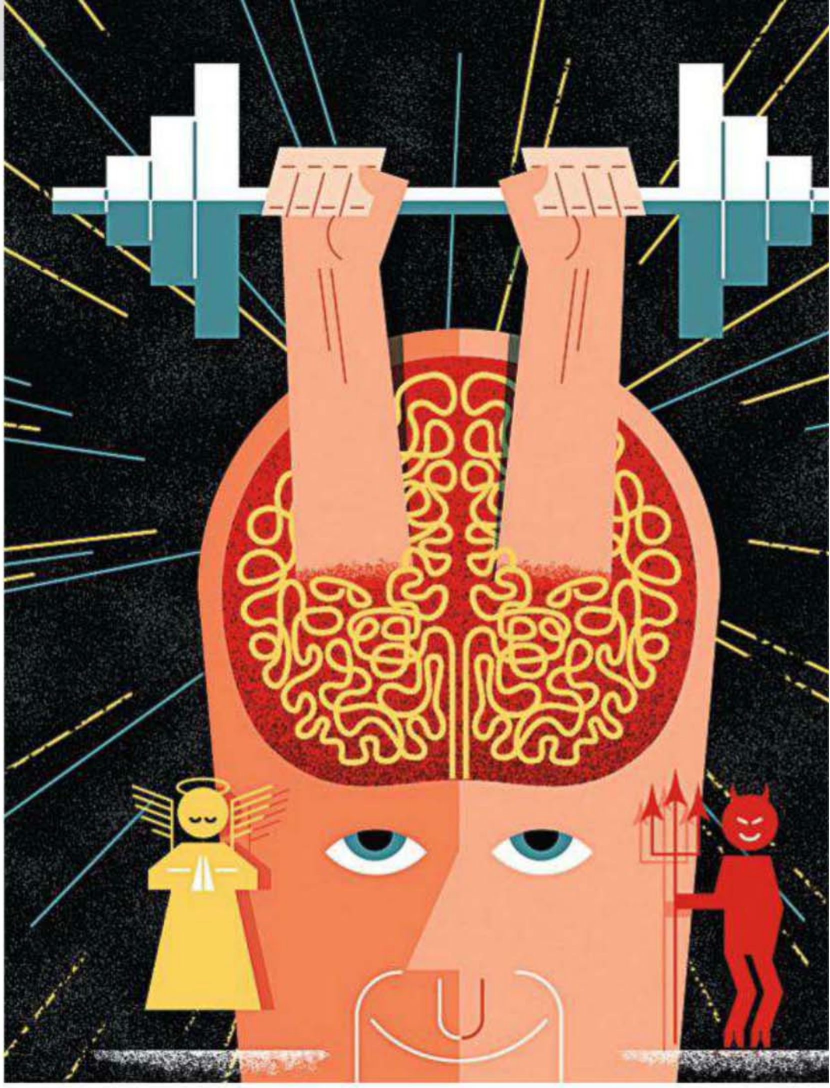
If you're with the armed resistance, try firing a shaped charge warhead at it. "You could use a high explosive squash head, which flattens out like a pancake when it hits. It then detonates and sends a shock wave through the armour which causes the inside to 'scab' and fly about inside." A recoilless rifle or anti-tank guided missile might also do the trick.

CREATE OBSTACLES

If you're short of military-grade weapons, there are a couple of other devious techniques. "You could dig an anti-tank ditch," suggests Marshall. "Make a trench deep enough, perhaps 1.5 metres. If a tank falls in, it can't get out." If you can't dig, build. Concrete pyramids known as "dragon's teeth" cause tanks to belly out and prevent climbing.

CLIMB ON

"Although a tank looks unbeatable, if it's on its own it contains a very nervous crew," says Marshall. Armour means reduced vision; these vehicles are vulnerable to a lone person creeping up. "Once close in, an attacker will be out of view. And if the tank separated from its crew, try prising a hatch open." Better still, negotiate peace. **Leila Johnston** *tanks-alot.co.uk*



HOW TO...
MASTER YOUR OWN WEAKNESS

Struggling with self-control? Luckily, there are shortcuts. Psychologist Roy Baumeister and journalist John Tierney, in *Willpower: Rediscovering the Greatest Human Strength*, explain how smarts are as important as self-denial. TC

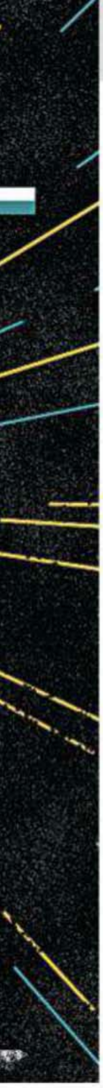
HOW TO...
MAKE A CHEAP LENS FOR A PHONE

The lens in a DVD player makes a cheap macro-lens smartphone add-on. Caleb Kraft

YOU'LL NEED
- Mobile phone with camera
- DVD drive from a computer or a DVD player
- Small Phillips-head screwdriver
- Razor blade, or X-Acto knife
- Piece of tape

SAFETY FIRST
A DVD player has high-voltage components. Unplug it and never turn it on when the housing is off. Looking directly at the laser can cause eye damage.

FIND THE LASER
Open the DVD player casing. Look for a small carriage with a laser mounted in the middle. This holds the focusing lens for the laser – the bit that you want.



SPOT THE SYMPTOMS

Willpower is a limited resource: resisting one thing means you're likely to succumb to another. In an experiment, researchers found that "while depleted persons didn't show any single telltale emotion, they did react more strongly to all kinds of things." Icy water felt colder; a sad film made them sadder. "Look not for a single symptom but a change in the intensity of your feelings."

MUNCH

Glucose depletion affects willpower dramatically. "If you have a test, an important meeting or a vital project, don't take it on without glucose," write Baumeister and Tierney. "Don't thrash out a problem with your partner just before dinner." To maintain steady self-control, eat foods with a high glycaemic index: "Most vegetables, nuts, raw fruit, cheese, fish, meat and olive oil."

SIT UP STRAIGHT

Researchers told a group of students to work on their posture for the next two weeks. When the fortnight was up, the students performed much better in self-control tests: "By overriding their habit of slouching, the students strengthened their willpower and did better at tasks that had nothing to do with posture." It doesn't have to be sitting up – any change in habits will help.

PRECOMMIT

It's easy to give up smoking after your 50th ciggie of the day, but after a couple of days fag-free, the situation is different. Use mental tricks to stay strong. First, precommitment: if you lock yourself into a path, it will be harder to leave it. Make this precommitment public – on Twitter, say. Be neat. If you're going to the gym, create an order in which you pack your bag and stick to it.

GET SUPPORT

A study in 2008 by Nicholas Christakis and James Fowler found that kicking the habit seemed to be contagious. If a member of a married couple quit smoking, the odds of the other quitting would increase sharply. The odds also got better if a brother, sister or friend quit. Even coworkers had a substantial effect, as long as the people worked together in a fairly small team.

NEVER DIET

High self-control doesn't make a difference when it comes to diet. "Whether or not you have good self-control, whether or not you exercise, if you go on a diet, the odds are that you won't permanently lose weight." One reason is biology. "The body might send you pain signals when you exercise too strenuously, but it doesn't treat jogging as an existential threat." Dieting is different.

PICK YOUR BATTLES

Try to use calm periods to plot your offensives. Stopping smoking, taking up exercise or cutting back on drinking "are all best done in times of relatively low demand, when you can allocate much of your willpower to the task. You can then pick your battles – and figure out which ones are too much trouble." And get enough sleep. "A rested will is a stronger will."

ILLUSTRATIONS: CLEAR AS MUD; ANDREW CLARK

REMOVE LENS
Carefully pry the lens from its housing. You may need to cut through glue – a razor or other thin blade is ideal. You may also need to break some plastic tabs.

MOUNT IT
Clean the camera lens. Stick the flat side of the DVD lens to the camera lens with small strips of tape. The rounded side should be sticking out away from your camera.

HOW TO...
PAINT ANTS

Ever tried to tell ants apart? Insect biologists grapple with this every day. When Andrew Quitmeyer worked at an ant-behaviour lab at Arizona State University, he was blown away by the scientists' solution. "They manually paint them," he says. Here's how to daub a colony. MV

1. ASSEMBLE YOUR TOOLS
Set up with paint (the stuff for plastic models is fine) and mini-brushes of "single strands of human hair", says Quitmeyer. Bring a microscope and some carbon dioxide (try an aquarium supplier). Anaesthetise your ant. Secure it face down on a sponge bed, tied with a strand of hair.

2. PAINSTAKINGLY CODE
Slide the ant under your microscope and pull out a chart that lists a four-colour mix for each ant in the colony. Use the hair-brushes to dot the colours on to the head, thorax, and left and right abdomen. Pull out the ant with forceps. You have about three minutes until it wakes up.

3. DRY OFF
Slip the painted ant into a drying chamber, such as a small plastic dish. "They sit there, wake up slowly and dry off quickly, without rubbing off paint on to others in the colony," says Quitmeyer. The whole process takes novices about 15 minutes per ant; experts manage it in five.

4. SIT BACK AND WATCH
Once every ant has been marked, you can track each as it goes about daily life. "We're looking at communication – which ants talk to each other, how often and when," says Quitmeyer. Although scientists enjoy painting their ants, Quitmeyer's ultimate goal is to create a robot ant painter.

HOW TO...

SEND BALLOONS INTO SPACE

Canadian teenagers Asad Muhammad and Mathew Ho sent a Lego minifig 24,384 metres up (near-space) using a balloon. Ho explains how. **Stephen Kelly**

KEEP IT SIMPLE
"We used a box fixed to a parachute attached to a giant weather balloon," says Ho. Order the parachute from spherachutes.com and the balloon from kaymontballoons.com. The 350g model should be fine, but a bigger balloon will last longer in the air.

BE PREPARED
A party shop can supply the helium. The duo cut holes in the box for their camera lenses, which were held in place with Super Glue and set on automatic trigger with CHDK software. Drop in a cheap web-enabled mobile phone, then insulate the box.

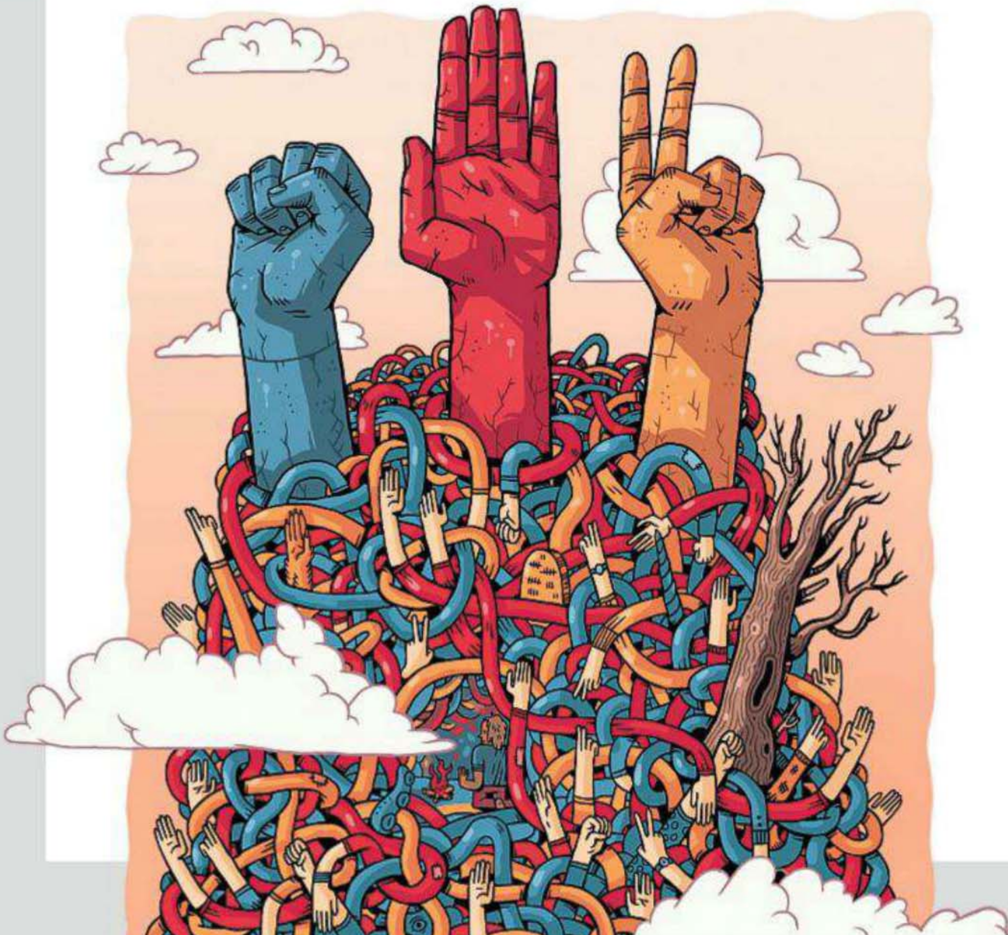
LIFT OFF!
Get permission from the Civil Aviation Authority to avoid launching your balloon into restricted airspace or colliding with another aircraft. Also, says Ho, "make sure the weather is right. You need low winds so you don't get blown off course."

RETRIEVE IT
When your balloon pops, there's no guarantee where it will land. "We used a free GPS app called Instamapper," says Ho. "You can download it for iPhone or Android and it can pinpoint the signal from the, web-enabled phone left in the container."

HOW TO...

MASTER ROCK-PAPER-SCISSORS

Rock-paper-scissors isn't simply a random and childish way to decide trivial outcomes: it's serious stuff, and completely winnable – if you know a few tricks. Douglas Walker, co-author of *The Official Rock-Paper-Scissors Strategy Guide* and organiser of the RPS World Championships, explains why "rock is for rookies". TC



SPOT THE SEQUENCE

"People see it as too predictable to throw a rock five, six or seven times," says Walker. Beginners tend to throw only three of the same shapes in a row. If they've been throwing rock, that means they will throw either scissors or paper. Throw a scissors yourself and you'll earn at least a draw.

BE SEXIST

Walker's research suggests that rock is the favourite move, at 37 per cent of all throws. Paper is 35 per cent and scissors 29 per cent. When all else fails, go for paper. Or go with gender: "Guys are close to 50 per cent likely to open with rock. Females tend to start with scissors."

PLAY DIRTY

On the first throw, come in obviously late on the count. Apologise profusely, but take note of your opponent's throw. "Most people are likely to play the same throw again." It's frowned upon in competitions, but in a street match, well, it all depends on what you can get away with."

USE JEDI MIND-TRICKS

"I tell you I'm going to play rock. Then I look into your eyes and see if there's a smile there, because that indicates you don't believe me, making scissors a safe bet. A lot of it is about eliminating the likelihood of a certain throw, turning an unknown situation into a tie or a win."

READ YOUR OPPONENT

A clenched jaw and generally aggressive stance is often indicative of rock about to come. A more reserved, open stance can suggest paper. "Scissors – that's hard to predict," says Walker. Don't trust your gut, though: "Because your gut is probably leading you to be predictable yourself."

PLAY BLINDFOLDED

Richard Cook at UCL found that sighted players threw their moves about 200 milliseconds after a blindfolded opponent, suggesting imitation, and blindfolded players scored more wins. Walker also recommends speeding the game up. "People are most predictable when you speed up play."

HOW TO...

CREATE A WIRELESS iTUNES LIBRARY

You've got a killer hi-fi – so why not turn it into the loud end of a wireless iTunes audio system? Here's how to get hooked up. Nate Lanxon (editor of wired.co.uk)

1. USE THE BEST SOURCE
Use CDs. Rip them into iTunes with the Apple Lossless quality option, in the Import Settings section of the Preferences menu.

2. GET AN APPLE AIRPORT EXPRESS
This inexpensive device is a home-network extender. It supports Apple's AirPlay system for streaming audio, plus optical digital output.

3. USE OPTICAL DIGITAL CABLES
Optical digital cabling rather than analogue transfers music from the Airport Express with bit-for-bit accuracy, as if it were still from a CD.

4. USE A GOOD-QUALITY DAC
A DAC is a digital-to-analogue converter. Try Cambridge Audio's DacMagic or an alternative from Beresford. They're pricey, but worth it.

5. HOOK YOUR DAC TO YOUR HI-FI
All that's left is to connect your hi-fi and crank up the volume. Assuming you've got a great hi-fi – but that's a different story.

ILLUSTRATIONS: KELSEY HEINRICHS; MITCH BLUNT; PHIL WRIGGLESWORTH; KYLE T WEBSTER

HOW TO...

LAND A PLANE WHEN THE PILOT IS OUT

Your light aircraft suddenly starts to drop out of the sky, the pilot is slumped senseless over the controls and the ground is getting closer by the second. John Hartill, chief flying instructor of the Airways Flying Club and wish.co.uk, talks us down. Leila Johnston

1 DON'T PANIC

This is perhaps easier said than done, but panicking won't bring the pilot back – and on the contrary, it may well make things considerably worse. "Try to stay calm," advises Hartill. "Take a deep breath and assess the situation."

2 STAY LEVEL

"If the nose is noticeably below the horizon, the aircraft is losing height," says Hartill. "Gently pull the control column towards you until it stops descending." If you're climbing, push the column forwards, and rotate it if the plane is turning.

3 MAKE A RADIO CALL

"Put on the pilot's headset, look for the press to transmit (PTT) button on the control column, hold it and say, 'Mayday mayday mayday'. Tell the controller what has happened then take your finger off the button and listen for their instructions."

4 USE THE THROTTLE

Having reached an airfield, use the throttle to start a descent. "It's a lever or plunger-type control with a black handle," says Hartill. "Reduce power by moving the throttle lever back or pulling the plunger out and the plane will lose height."

5 CONTROL THE AIRSPEED

Find the airspeed indicator dial. "It has coloured bands around it. Aim to keep the airspeed in the green zone," Hartill advises. Airspeed correlates with the angle of the nose: push the column away from you to increase speed and pull it to slow down.

6 TRIM OUT PRESSURE

As you descend towards the runway you will have to put the flaps down, with the help of air-traffic control. "This will create pressure on the control column," warns Hartill. "Get rid of it using the trim wheel between the front two seats."

7 LAND ON THE BACK WHEELS

"As you fly above the runway, close the throttle by moving it back as far as it will go," says Hartill. "Then gently move the control column towards you and hold it there. The aim is to keep the nose slightly up, so you don't land on the front wheel."

8 PUT THE BRAKES ON

Congratulations, you have landed the aircraft – but it is still rattling along the ground, and you can't drive it home. "Locate the rudder pedals, and push them gently and evenly with both feet," says Hartill. "This will apply the brakes."

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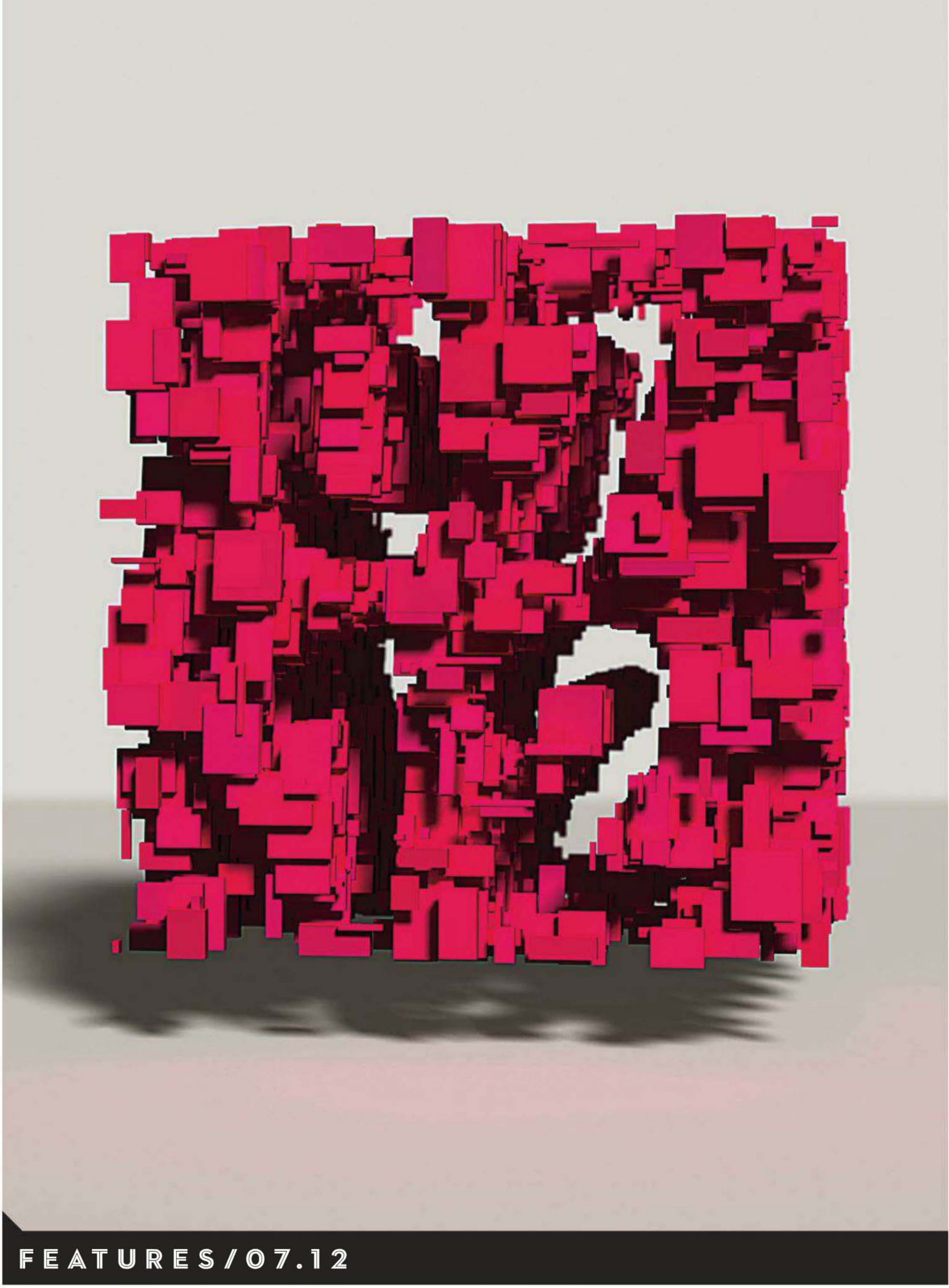

ILLUSTRATION: GIUSEPPE RANDAZZO [NOVASTRUCTURA]. SYSTEM-CODED USING PROCESSING AND RENDERED WITH 3DELIGHT

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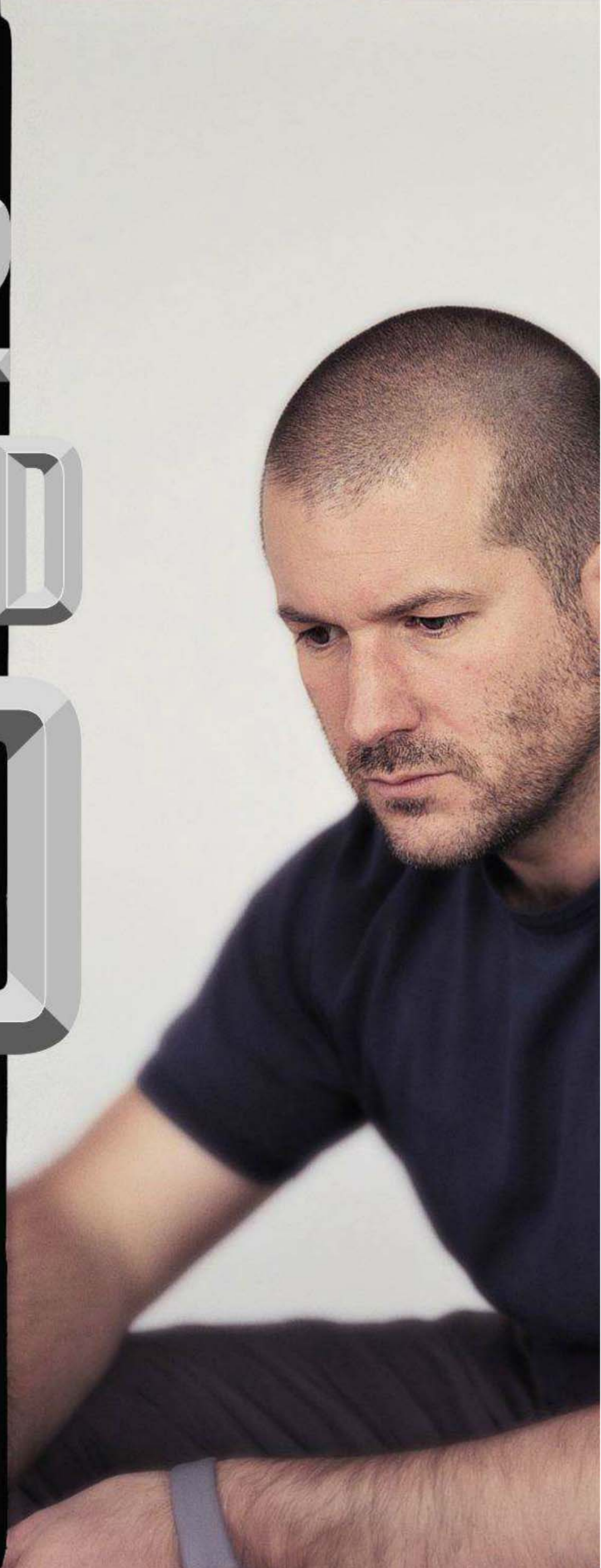


★ Our third annual survey of the UK's digital power-brokers. From innovators to investors, meet the people our panel and readers see as key figures in 2012

Research by: GREG WILLIAMS, TOM CHESHIRE, MADHU VENKATARAMANAN, DAN SMITH, MATT HUSSEY

Photography: JOE MCGORTY

01

JONATHAN IVE

SENIOR VICE-PRESIDENT OF INDUSTRIAL DESIGN, APPLE INC

▲ (07)

For a man who has done more than almost any other industrial designer to change our relationship with technology, Sir Jonathan Ive is remarkably unassuming. Softly spoken and eloquent, Jony (as he is known to his friends) has shaped every curve, switch and icon on Apple products from the candy-coloured iMac introduced in 1998 to the iPad 3 with its retina display.

In the last twelve months, Apple has become the world's most valuable company – it currently has a market capitalisation of £350bn – because of its ability to create entirely new categories of devices and entire ecosystems based around them. Ive is a man with a deep understanding of the products he creates – from the formula of the glass used in the iPad's screen to the layout of the box it arrives in.

His obsession with detail is legendary, as are the sources of his inspiration: a confectionary maker helped get the colour of the first iMac just right; a Japanese swordmaker taught Ive about the properties of metals for use in laptop bodies. Ive also helped transform public perception of his field: many in the design world believe he has changed the face of their profession.

Ive has become a household name, receiving a knighthood for services to the design industry is the last New Year's Honours, which he describes as "humbling".

"The work that Ive has done with Apple is the most powerful demonstration that there is nothing fluffy or cosmetic about design," says Deyan Sudjic, director of London's Design Museum. "It is what created the world's most valuable company."

Sudjic believes it is hard to overestimate the broader impact of Ive's work on society. "He has made his reputation not with chairs or lemon squeezers but with the electronics that have reshaped the way that most of the world works, communicates, navigates, takes pictures and listens to music," he says. "What makes him stand out in a profession not known for its shrinking violets is his modesty and his intensity. His work speaks for itself. He doesn't need to sell it, and he has shown us that design means something – at a time when it risked being trivialised by too much designer tat."

Ive, 45, has kept his strong British accent despite having moved to San Francisco in 1992. Shaven-headed and obviously no stranger to the gym, Ive is typically impeccably dressed, and speaks in a way that suggests every sentence and every word has been carefully thought through. Colleagues talk of his incredible enthusiasm for work, his face lighting up when he talks about it, and he can't help but grin infectiously when explaining a feature or solution to a problem he is particularly pleased with.

Born in February 1967 in Chigwell, he attended the same school as David Beckham (although several years apart). Ive says he inherited a love of making things from his father, a silversmith, and his fascination with the detail of design began early.

As a kid, I remember taking apart whatever I could get my hands on," he told the Design Museum in a rare interview in 2003, after he was named its inaugural Designer of the Year. "I knew that I wanted to design but I had no idea what – I was interested in everything: cars, products, furniture, jewellery, boats."

Ive attended Newcastle Polytechnic – now Northumbria University – where he studied industrial design. This was also where he first came across the Mac. He says his first impressions on seeing the device were of feeling a connection with its designers: "There was a real sense of the people who made it."

After a brief stint as a commercial designer, Ive founded a design agency called Tangerine with three friends.

"Jony is a very unique individual as well as a very gifted designer," says Clive Grinyer, who set up Tangerine with Ive, and is now director of customer experience at Cisco's Internet Business Solutions Group. "He remains the most honest, dedicated, unaffected by fame and likeable person – let alone designer – you could meet."

Grinyer says that right from the start of his career, Ive expressed an intense dislike of the technical specs relied on by many of Apple's competitors to sell products. "Jonathan always hated technogabble, the macho shouting of features and performance that meant nothing to real people. He thinks with great clarity about what is really important to people, functionally and emotionally, and that is what he shared with Steve Jobs. Like every designer, he wants to shape the world and help it be sensible and useful to everyone – only he really did it."

Grinyer also offers a rare insight into what working with Ive is like, describing him as "a great leader – an inspirer".

It was while working at Tangerine that Ive first came into contact with Apple – which then poached him. It's something Grinyer still laments. "We all regret that he had to leave the company we started together in Shoreditch, [which we] fought to make successful in the unfriendly climate of a 90s UK industry that did not appreciate or sustain his talent. California has provided the culture, climate and stage for his dedication to designing the best products he and his colleagues can possibly create."

However, after he joined Apple, Ive was effectively sidelined until the return of Steve Jobs to the firm in 1996. His relationship with Jobs is considered the key to his success – Jobs described Ive as his "spiritual partner" in Walter Isaacson's recent biography of the Apple cofounder.

> **'IVE IS MORE IMPORTANT WITHIN APPLE NOW. I THINK OF HIM AS ON A PAR WITH CEO TIM COOK IN THE WAY DECISIONS ARE MADE. HE'S A DOWN-TO-EARTH GUY, WHICH IS RARE FOR A DESIGNER'**
>
> CAROLINA MILANESI, RESEARCH VP, GARTNER

Jobs and Ive forged their relationship over the iMac, which marked Ive's arrival as a world-beating designer capable of creating devices with mass appeal.

After the iMac, Ive's instantly recognisable work continued with the iPod, iPhone and iPad – each one radically changing the way we interact with technology. His team is small and interdisciplinary – it includes silicon designers and electronic and mechanical engineers. "You would struggle to determine who does what when we get together," he says.

"Our goals are very simple – to design and make better products," he says. "If we can't make something that is better, we won't do it." Models are key to the design process, and he admits that only when his team come to create the first models of a new product does it begin to come alive.

"When you make a 3D model, however crude, you bring form to a nebulous idea, and everything changes – the entire process shifts," he recently explained. Although his workspace is completely off limits to virtually all on the Apple campus, Ive has described it as a "large open studio and massive sound system." One of Ive's friends, DJ Jon Digweed, will sometimes provide the soundtrack the team work to.

Ive lives in a relatively modest house in San Francisco with his wife, Heather Pegg, who he met at secondary school in London, and their twin sons. He commutes to Apple's headquarters in Cupertino every day. Rarely interviewed or photographed in public, Ive's public image has been carefully controlled – but this may be changing.

Carolina Milanesi, research VP at analysts Gartner, has monitored Apple for several years and has noticed Ive gradually emerge from the shadows. "He has been working for Apple for such a long time, and really is seen as the man behind the products," she says. "He is far and away the most influential designer working today, but since Steve Jobs stood down and then passed away, his profile has really stepped up – people really look to him, he seems to be playing a very different role now."

Jobs and Ive were a common sight on Apple's vast Cupertino campus, often having lunch together at Caffe Mac, its on-site restaurant. At a celebration of Jobs's life held just yards away from their lunch spot, Ive made a rare public speech about his friend, saying: "Just as Steve loved ideas and loved making stuff, he treated the process of creativity with a rare and a wonderful reverence."

At the memorial event for Steve Jobs on campus, he really came across as more of a front person for Apple, underlining how close he was to Jobs," Milanesi says. "I think he is more important within the company now. I think of him as being on a par with Tim Cook in the way decisions are made. He's a down-to-earth guy, which is rare for a designer, and it makes him very accessible to people."

As Apple's new CEO Tim Cook likes to say (frequently), there is more to come from Ive and his team. Besides the impending iPhone 5, Ive's lab also holds the secrets of Apple's plans to dominate the living room, with rumours of a big-screen TV. He also has another, very different project on the horizon – Apple's new "spaceship" campus in Cupertino, on which he has said he is "working very closely" with Sir Norman Foster. It is likely to be a lasting legacy to Steve Jobs – as well as giving Ive the opportunity to have an even bigger stereo-system installed in his lab.

For all these qualities and for his outstanding achievements in 2012, our panel deemed Jony Ive the most influential individual in Britain's extended digital economy. **Mark Prigg**

PHOTOGRAPHY (PREVIOUS SPREAD): DAVID LEVENE/EYEVINE

02 MICHAEL LYNCH

EXECUTIVE VICE PRESIDENT, HEWLETT-PACKARD; FOUNDER, AUTONOMY

★(NEW ENTRY)

Having pulled off Europe's largest ever sale of a software company – Autonomy to Hewlett-Packard for $11.7bn (£7.1bn) – Lynch could be expected to relax. But he's splitting his time between the UK and Palo Alto and continues to work on making computers understand human-friendly data. About £500 million better off, he is looking for new ventures to fund.

03 DAN COBLEY

MANAGING DIRECTOR, GOOGLE UK

★(NEW ENTRY)

Cobley is Google's sort of marketer: he has a degree in physics. He worked for Pepsi, Ask Jeeves and Capital One before joining Google in 2006 as director of marketing for northern and central Europe. In October last year he stepped into Matt Brittin's shoes as managing director of Google UK – responsible for 11 per cent of the firm's global $38bn revenue in 2011. Cobley has also spoken at TED.

04 JOANNA SHIELDS

VICE PRESIDENT AND MANAGING DIRECTOR, FACEBOOK EUROPE, MIDDLE EAST AND AFRICA

▼(01)

A pivotal figure in Europe's internet industry for 12 years – with former roles at Bebo, AOL and Google – Shields continues to influence Facebook's mobile strategy and to develop opportunities for startups and social shopping. Last year's number one has forged partnerships with fashion icon Burberry and gaming firms Nordeus and Wooga.

05 MICHAEL ACTON SMITH

CEO, CREATIVE DIRECTOR AND FOUNDER, MIND CANDY

▲(12)

Acton Smith, 37, has created a hugely popular online game for children – 60 million from 150 countries log into *Moshi Monsters* each month. His firm, Mind Candy, is also a media empire: the *Moshi Monsters* magazine is the UK's best-selling children's title, and this year the brand released a music album; £62 million of Moshi products were sold in 2011. He has a crack at an ultra-high-value exit.

06 INDEX VENTURES

VARIOUS PARTNERS, VENTURE CAPITAL FIRM

▲(31)

The 29 investors at Index Ventures play a team game. In 2011 alone they invested in 48 companies, including EDITD, onefinestay and Songkick, and raised a £122 million fund for life sciences. With a new office in Silicon Valley, partner Saul Klein tells WIRED that they "believe in acting as a bridge between the most talented entrepreneurs on our side and connecting them directly into the Bay Area."

07

DANIEL EK

COFOUNDER AND CEO, SPOTIFY

▲(08)

Last year the unstoppable Ek conquered America – and then Facebook, for good measure. This year he has set his sights on the entire web, launching a play button that can be embedded into any site. London-based Spotify has already signed up big media brands *Time Out*, Tumblr and *Vogue* (owned by Condé Nast Publications, publisher of WIRED) to push the feature. Ek is also seeking additional funding for Spotify that would value the company at $4 billion – up from the $1.1 billion valuation it achieved last summer, and making it worth more than Warner Music (sold for $3.3 billion in 2011); Ek's personal stake would be worth more than £200 million. The company still hasn't turned a profit, but the latest figures show that 30 per cent of Spotify's ten million users are paying for the service, giving hope to the music industry and making Ek the most influential person in it.

08 NIKLAS ZENNSTRÖM

PARTNER, ATOMICO

▲(19)

Skype founder Zennström invested $42 million (£26 million) in Rovio in 2011; recently the *Angry Birds* developer has been valued at $6 billion. In November Atomico led $5.5 million of funding for Wrapp, a social gifting service, and this spring pumped cash into *Hailo*, a taxi app. Naturally shy Zennström is becoming more visible on the conference circuit at events such as Founders Forum and LeWeb.

09 ACCEL PARTNERS

VARIOUS PARTNERS, VENTURE CAPITAL FIRM

▲(29)

One of the most global venture capital outfits, this 30-year-old firm's aim is to back companies that will be category leaders in everything from consumer tech to big data. With nearly 80 per cent of investments at early stage, including fast-growth startups such as Wonga, Mind Candy, Groupon, Rovio and Stylistpick, Accel partner Sonali De Rycker says she is open to risk.

10 BRENT HOBERMAN

INTERNET INVESTOR AND SERIAL ENTREPRENEUR

▼(06)

Tech City signed up lastminute.com founder Hoberman to entertain investors during the Olympics – and persuade them to back businesses here. He invests personally and through PROfounders Capital, with recent investments ranging from onefinestay to Made.com and easyCar. His Founders Forum, an annual tech showcase run with Jonnie Goodwin (27), has launched outposts in Rio and New York.

11 ROHAN SILVA

SENIOR POLICY ADVISER TO DAVID CAMERON

▲(41)

Placed firmly at the heart of the Conservative Party's digital strategies, Silva, 31, champions projects such as the Tech City development in east London. Silva's 30-place rise reflects his increasing influence on policies such as the Enterprise Investment Scheme and the Entrepreneur Visa. His current big idea – open-source government – involves crowdsourcing policy initiatives.

12 PETE CASHMORE

FOUNDER AND CEO, MASHABLE

▲(80)

Mashable, which Cashmore started when he was 19, claims more than 50 million page views a month; the website has contributed to a personal fortune estimated by the *Sunday Times* Rich List at £60 million for the Scottish entrepreneur. Now his Social Good Summit, in partnership with the United Nations Foundation, means Cashmore has a global influence beyond rapid-fire tech blogging.

13 MIKE BRACKEN

EXECUTIVE DIRECTOR OF DIGITAL EFFICIENCY AND REFORM GROUP, CABINET OFFICE

★(NEW ENTRY)

Bracken took up his government post last July, after revamping *The Guardian*'s online services and helping found mysociety.org; he spent his first months creating the Government Digital Service, a team within the Cabinet Office working to transform the UK government's current digital offering and create a framework for all government services online.

14 IAN OSBORNE

PARTNER, OSBORNE & PARTNERS; PARTNER, DST

★(NEW ENTRY)

You probably haven't heard of Osborne – and he wasn't keen on being in this list. But he's a gatekeeper who advises political and business leaders on international affairs through his strategic advisory firm Osborne & Partners. His firm has represented tech founders ranging from Sean Parker to Summly's Nick D'Aloisio, on whose board he sits. He's also partner and director at late-stage investors Digital Sky Technologies.

15 MARTIN CLARKE

EDITOR, MAILONLINE

★(NEW ENTRY)

Clarke took over MailOnline in 2006, switching the focus to human-interest, celebrity-based stories and emphasising the US. Under him, the website reached 4.53 million daily users in December 2011, passing the *New York Times*'s 4.48 million. In January 2012, ComScore announced that MailOnline had become the world's most-read news resource. Clarke estimates that MailOnline will take £25 million in revenue this year.

16 IAN LIVINGSTONE

LIFE PRESIDENT, EIDOS

▲(54)

The most recent budget, which gave tax breaks to video-game developers, was a big win for Livingstone, who had been campaigning on the issue for years. The veteran developer is now doing it for the kids – he had another political success earlier in the year when he persuaded Michael Gove to include computer science as a GCSE, and is helping develop a new national curriculum for ICT.

17 MARK WALPORT

DIRECTOR AND CHIEF EXECUTIVE, WELLCOME TRUST

★(NEW ENTRY)

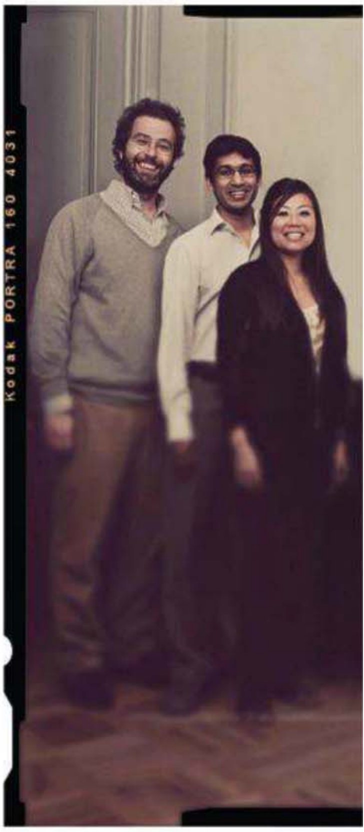
Fellow of the Royal Society and a member of the Prime Minister's Council for Science and Technology, Sir Mark heads the Wellcome Trust, a charity spending £600 million annually on research to improve health. An open-data champion, he aims to change the trust's funding policy to ensure that details of publicly funded research are freely available within six months of first publication.

18 STEFAN GLAENZER

ANGEL INVESTOR, CEO AND FOUNDER OF WHITE BEAR YARD

▼(13)

Seed VC firm Passion Capital, cofounded by former last.fm executive chairman Glaenzer, has only been around one year. But it's been busy, using its £37.5 million fund to back 20 companies, including Twilio, Mendeley, Luluvise, Flattr and Smarkets. Glaenzer aims to fund 50 startups by 2016, making it the third most active seed fund globally, behind SV Angels and First Round Capital.



19 EILEEN BURBIDGE

COFOUNDER, WHITE BEAR YARD; PASSION CAPITAL

★(NEW ENTRY)

Starting as the product head of a young Skype in 2004, Burbidge has come a long way. She now sits on the boards of Mendeley, social-payment service Flattr and fashion site Stylistpick. In 2009, with Stefan Glaenzer and Robert Dighero, she set up White Bear Yard, a London hub for startups. In 2011, the same team founded Passion Capital, which provides early-stage funding for tech firms.

20 ROBIN KLEIN

FOUNDER, THE ACCELERATOR GROUP

▲(21)

A serial entrepreneur since the 70s and founder of the Accelerator Group, Klein is an old hand at betting on fast-growing tech businesses. Although a partner at his son Saul's firm Index Ventures (see entry 6), he is on the board of startups Wonga and onefinestay, and incubator Seedcamp.
Last year, Klein advised the UK government on how to cultivate innovation in the tech sector.

21 MATT BRITTIN

VICE-PRESIDENT FOR NORTHERN AND CENTRAL EUROPE, GOOGLE

▼(04)

In October last year, Brittin stepped up from managing Google's UK operations to take control of the search giant's interests in northern and central Europe. Still based in London, he opened the Google Campus in Tech City and wants the city "to become a hub for technology in Europe". And yes, he represented Great Britain in rowing at the 1988 Olympics.

22 LOIC LE MEUR

FOUNDER, LEWEB

★(NEW ENTRY)

Le Meur is founder and CEO of Seesmic, a social media management company, but it's his role as organiser of the LeWeb conference that has won him praise from the likes of Eric Schmidt and Sean Parker. Each December in Paris, the event brings together entrepreneurs, investors, geeks, press and tech superstars such as Eric Schmidt and Sean Parker in 2011. This June, LeWeb makes a trip to London.

23 OLIVER SCHUSSER

SENIOR DIRECTOR, iTUNES EUROPE

▼(09)

iTunes is by far the largest music retailer in the world. Recent milestones include singer Adele (44) becoming the first artist to have a million-download album and single on the European store. Schusser stays under the radar, but the former Napster staffer can make artists by featuring them on the store, and is overseeing Apple's tentative steps into video-on-demand in Europe.

24 TIM BERNERS-LEE

DIRECTOR, W3C; INVENTOR OF THE WORLD WIDE WEB.

★(NEW ENTRY)

Sir Tim has become more outspoken this year – urging users to demand their personal data from online firms, and criticising the music industry for impeding the open web. He now runs the W3 consortium, which creates and maintains global web protocol; he also launched data.gov.uk in 2009. He is working on the Semantic Web, an evolved version of the current text-based system.

25 RESHMA SOHONI

PARTNER, SEEDCAMP

▼(17)

Five years after setting up Seedcamp, Sohoni predicts 11 of the first 16 funded companies still standing will generate at least $1m (£600,000) in revenues in 2012. Sohoni has built a 1,200-strong network of mentors for the incubator that reads like a *Who's Who* of tech, and expanded mini-Seedcamps across Europe. Seedcamp's investments typically focus on gaming, financial services, travel, B2B and fashion startups.

26

PADDY COSGRAVE

FOUNDER, DUBLIN WEB SUMMIT, F.OUNDERS

▲(67)

Dublin-based entrepreneur Cosgrave is a master connector. Organiser of two big tech conferences – the Dublin Web Summit and F.ounders – the 27-year-old manages to convince leaders of the digital world to speak at his events, including founders of Twitter, LinkedIn, Skype and YouTube. His Dublin guests have ranged from Bono to then-Irish President Mary McAleese.

Cosgrave cofounded the Undergraduate Awards of Ireland in 2009 and was recently selected by the World Economic Forum to join a new group of leaders under 30 from around the world, known as the Global Shapers.

In March, Cosgrave curated the London Web Summit with TechCrunch Europe editor Mike Butcher to recreate the same creative, community spirit in the UK. Over 700 attended to hear speakers including Zynga, Google and Mashable.

Index Ventures team from left to right: David Rimer, Shardul Shah, Malin Gustafsson, Pascal Jouin, Danny Rimer, Saul Klein, Bernard Dallé, Leonard Picardo, Ben Holmes, Michèle Ollier, Mike Volpi, Dominique Vidal, Martin Mignot, André Dubois, Neil Rimer, Richard Lee, Nina Faulhaber, Kevin Johnson, Francesco De Rubertis, Roman Fleck, Giuseppe Zocco, Jan Hammer, Gerald Rimer

27 JONNIE GOODWIN

COFOUNDER, FOUNDERS FORUM; PROFOUNDERS CAPITAL; LEPE PARTNERS

★(NEW ENTRY)

Goodwin's focus this year has been Lepe Partners, a merchant bank dedicated to the media and digital sectors, which he cofounded in September 2011. The bank will invest its own money with the money it helps raise, and will advise digital firms on mergers and buyouts. His influence is boosted by co-hosting the Founders Forum, which gives him access to everyone.

28 SHERRY COUTU

ENTREPRENEUR AND ANGEL INVESTOR

▼(24)

With Reid Hoffman, Sherry Coutu brings over some of Silicon Valley's biggest players to the UK every year, earning David Cameron's attention. The angel investor still backs startups, recently funding Brainient, Recurly and Klout competitor PeerIndex, but she also brings her savvy to non-business ventures such as Cambridge University, Cancer Research UK and The Prince's Trust.

29 PHIL SMITH

CEO, CISCO UK & IRELAND; CHAIR, UK TECHNOLOGY STRATEGY BOARD

★(NEW ENTRY)

Smith heads up Cisco's largest operation outside the US and is the man behind Cisco's British Innovation Gateway, which provides cash, technology and consultancy for UK digital startups. In November 2011 he became chair of the UK Technology Strategy Board, which provides funding and support for tech and science-based businesses.

30 RALPH RIVERA

DIRECTOR, BBC FUTURE MEDIA

★(NEW ENTRY)

Rivera left Major League Gaming in New York to oversee all of the BBC's digital media products across computer, gaming and mobile devices in late 2010. In March 2011 he was promoted to director of Future Media, one level below the director general. He recently launched an innovative paid-download store for publicly funded BBC content, and the BBC *iPlayer* is accessible on more than 50 different internet-enabled devices.

06 INDEX VENTURES

VENTURE CAPITAL FIRM

▲(31)

In 2011, Index Ventures came full circle. The venture-capital firm started in Geneva in 1996, to "take the Silicon Valley mindset to Europe", according to partner Saul Klein. Five years later it opened a London office and backed some of the most successful companies in European tech: Skype, MySQL, Betfair, ASOS and LOVEFiLM, to name a few. Last year, it opened a San Francisco office – to bring a European mindset to the Valley. "We believe in acting as a bridge between the most talented entrepreneurs on our side and connecting them directly into the Bay Area," says Klein.

Index has helped newer companies such as Moo and Playfish to establish a US presence. But it's also backing firms from the Valley and New York: last year it invested in Dropbox, Etsy and Flipboard. In 2011, it raised a €500 million (£408 million) fund and a €150 million life-science vehicle, backed by pharmaceutical giants GSK and Johnson & Johnson, and had 15 exits. London, though, remains the "heartbeat" of Index: current companies include EDITD, Mind Candy, MOO, onefinestay and Songkick. The secret to the company's productivity (it made 48 new investments in 2011 alone)? Its 29 investors: "You can't do all of that unless you work as a team," Klein says. "That's the core ethos: this is a team game – this is total football."

PADDY COSGRAVE PHOTOGRAPH: KEVIN ABOSCH

09

ACCEL PARTNERS

VENTURE CAPITAL FIRM

▲(29)

Accel Partners is looking for the next billion-dollar company – wherever it may be. The 29-year-old venture capital firm has spilled out of its headquarters in Palo Alto and charged into Europe, India and China. "We want to help businesses regardless of their geographical origin and where they want to expand to," says Sonali De Rycker, a partner at Accel's London office in St James's.

In the last year, the $530 million London fund has made 17 investments in nine countries – including Russia, Israel, France, the UK and Sweden. "We've now proven that tech talent is everywhere," says De Rycker.

Having swooped in early on startups such as Wonga, Rovio, Groupon and Mind Candy, De Rycker says a vast majority of Accel's investments are early-stage, with little or no revenue. "We want to back companies that will eventually be number one in their category," she says.

The firm's most successful exit was a Swedish startup called QlikTech, which analyses complex datasets in a user-friendly way. Accel made an initial $10m investment in the company in 2004 and returned over $400m, when QlikTech went public in 2010. "We are told it is one of the largest venture returns in European history," De Rycker says. Accel formed a $100m Big Data fund in November last year. "The levels of innovation we are experiencing today are almost unprecedented," says De Rycker. "These tectonic shifts are what make the job of a VC so exciting."

Accel Partners team from left to right: Michiel Kotting, Harry Nelis, Sonali De Rycker, Bruce Golden, Kevin Comolli, Adam Valkin

31 CHARLES DUNSTONE

CHAIRMAN, CARPHONE WAREHOUSE

★(NEW ENTRY)

Dunstone's joint venture with Best Buy, which brought the US electronics retailer to the UK for the first time, ended with the closure of all 11 stores. But Dunstone is extending his influence outside Carphone Warehouse, and into finance by investing in mobile payment services such as Mobile Money Network and iZettle (the European equivalent of Jack Dorsey's Square), which is due to launch soon in the UK.

32 DANNY TRUELL

CHIEF INVESTMENT OFFICER, WELLCOME TRUST

▲(34)

Truell, 48, is a former Goldman Sachs fund manager who now guides the tech investments of the UK's largest charity. Nearly 20 per cent of its £14 billion portfolio is now invested as venture capital rather than in lower-return government bonds and commercial property, with the proceeds funding the charity's science grants. The trust is benefiting from early investments in companies such as Twitter and Facebook.

33 GEOFF MULGAN

CEO, NESTA

★(NEW ENTRY)

The incoming chief of NESTA (National Endowment for Science, Technology and the Arts) has overseen its new independence from government as a charity, and begun rethinking its role as an investor and promoter of innovation. The Demos founder has also set up the Alliance for Useful Evidence, which aims to use research to channel public money more effectively, through evidence-based decision making.

34 JIMMY WALES

COFOUNDER, WIKIPEDIA

★(NEW ENTRY)

Last year the Wikipedia cofounder ditched Silicon Valley for London and has proved a champion for the UK capital as a centre for digital businesses. He's been vocal in his condemnation of the US's SOPA and PIPA internet bills and was drafted by the UK government to help make all taxpayer-funded research publicly available for free. In 2012, *Encyclopaedia Britannica*, old-school rival to Wikipedia, put an end to its print edition.

35 RICHARD MOROSS

FOUNDER & CEO, MOO.COM

▲(33)

With offices in London and Rhode Island, the online business-card startup has celebrated its fifth birthday with increased US sales and a boost in staff from 65 to almost 100. It also launched Luxe cards – three times thicker than regular cards and printed with a seam of colour – and in January won a contract to offer Facebook users business cards based on their Timeline. His influence is boosted by being a landlord to startups and Index in Scrutton Street, London.

36 MARTHA LANE FOX

UK GOVERNMENT DIGITAL CHAMPION; FOUNDER, RACE ONLINE 2012; FOUNDER, ANTIGONE

▲(43)

The lastminute.com founder is now a government adviser on digital inclusiveness. She set up Race Online 2012 to reach the eight million Britons who have never used the internet; Go ON UK aims to improve the IT skills of SMEs and charities. She is active in pushing the government's "digital by default" agenda, whereby public services will be delivered online.

37 RACHEL WHETSTONE

SENIOR VICE-PRESIDENT OF COMMUNICATIONS AND POLICY, GOOGLE

★(NEW ENTRY)

Whetstone is the mouthpiece of Google. Not an easy position, considering the continued allegations about the search giant's over-zealously tracking user data and avoiding paying UK tax. Today the former chief of staff to the Conservative Party's Michael Howard is based in California, but she spent a great deal of 2012 in the UK, hence her inclusion on our list.

38 BRUNO GIUSSANI

EUROPEAN DIRECTOR, TED

▼(22)

Bruno Giussani can make you a star: the European director of TED curates the line-up for TEDGlobal, held every summer. An appearance on stage there can lead to hundreds of thousands of video views, media coverage and book deals. Giussani is also tending to TED globally, co-hosting the first TEDx summit this April, which brought together 700 TEDx organisers from around the world for the first time.

39 ERROL DAMELIN

FOUNDER & CEO, WONGA

▲(27)

So far this year, Damelin's money-lending service, Wonga, has completed 3.5 million loans, maintained its single-digit default rate (thanks to a proprietary algorithm) and has expanded to Canada and South Africa. In the UK, it now offers business loans of up to £10,000, repayable over a year. Damelin's next goal is establishing reputation-based micro-loans for borrowers in developing economies.

40 NICK ROBERTSON

CEO, ASOS

▲(42)

The online-only fashion retailer posted a 46 per cent rise in sales to £495m in the year up to March 31 – impressive, but still below expectations. Pre-tax profit for this period is estimated to be around £40m – the UK accounts for 40 per cent of Asos's sales. The company's web presence is evolving, with the Asos Fashion Finder, a Facebook store and new sites for Spain, Italy and Australia, as well as iPhone and iPad apps.

41 FRANK MEEHAN

VC CONSULTANT, HORIZON VENTURES

★(NEW ENTRY)

In September 2011, Meehan stepped down as CEO of INQ Mobile, the "Facebook phone" company he founded in 2008 with backing from Hutchison Whampoa's Li Ka-Shing, to work at Li's company Horizons Ventures. A former Siri and Spotify director, he now sits on the boards of several Horizons-backed companies including Fixmo, Tout, Trap.it, Summly, Tripboard and Magisto.

42 THOMAS HEATHERWICK

DESIGNER, FOUNDER, HEATHERWICK STUDIO

★(NEW ENTRY)

If you've travelled on the new Routemaster bus you've experienced a Heatherwick design first-hand. Billions worldwide will see the cauldron he created for the Olympic flame. The V&A is holding the first retrospective of Heatherwick's work, but the designer is looking forward: he's creating a biomass-fuelled power station for Teesside and several projects in Asia.

43 GERRY PENNELL

CIO, LONDON OLYMPICS

★(NEW ENTRY)

Pennell manages a team of around 450 IT engineers – both in-house and from suppliers including BT, Cisco, Acer and Samsung – who will control the Olympics' network infrastructure. Come July, they will be supporting critical applications such as the Commentator Information System and the results services, as well as monitoring thousands of servers, PCs and online security devices – all on a budget of £2.1 million.

44

ADELE

SINGER/ SONGWRITER

★(NEW ENTRY)

The 24-year-old artist has 27m Facebook "likes" and six million Twitter followers, making her by our reckoning the most influential UK musician on social media. In the US, her track "Rolling in the Deep" is currently the biggest-selling digital single by a female artist – 6.68 million downloads (compared to Lady Gaga's 6.62m for "Poker Face"). She was also the first artist to go double platinum on iTunes, selling two million copies of her album *21* there. According to data from the Official Charts Company, she sold an album (*19* or *21*) every seven seconds in 2011. Her iPhone and Android apps have been downloaded two million times – fans vie with each other to rack up in-app activity such as posting comments. And she went toe-to-toe with Spotify, refusing to include her albums on the service unless they were available only to paying subscribers; Spotify refused – so she went to rival Rhapsody.

45 TONY WANG

GENERAL MANAGER, TWITTER UK

▲(NEW ENTRY)

Since arriving in May 2011, Tony Wang has increased Twitter's London staff to around 30 people, moved it from Shoreditch to Marylebone, and expanded the business operation, going from five advertising partners last year to more than 100 now. The UK is "one of the most critical markets for Twitter": there are ten million accounts registered here, a higher penetration than any other country.

46 HERMANN HAUSER

DIRECTOR, AMADEUS CAPITAL

▼(10)

Thirty years after the company he founded created the BBC Micro computer, Hauser continues to influence British tech as director of Amadeus Capital, recently joining the boards of Tobii and Intune Networks. He is the patron of the Centre for Computing History in Haverhill, Suffolk. His next challenge: convincing Cambridge University to give away its intellectual property to catalyse the creation of more tech businesses.

47 AJAZ AHMED

CHAIRMAN AND FOUNDER, AKQA

▲(49)

Enjoying another year of growth, Ahmed's digital agency now has more than 1,000 employees spread across the US, Europe, Shanghai, San Salvador and – of course – London. Ahmed recently wrote in WIRED (06.12) that old-fashioned advertising was "redundant", and he has coauthored *Velocity: The Seven New Laws for a World Gone Digital* with Nike's Stefan Olander to prove his theory.

48 MIKE BUTCHER

EDITOR, TECHCRUNCH EUROPE, COFOUNDER, TECHHUB

▼(25)

The veteran tech writer wears many hats: networker, startup commentator, lobbyist and entrepreneur. As well as his duties as a founder of London's TechHub, he is on the steering committee for the digital legislation group Coadec. He also organised the London Web Summit – a version of his GeeknRolla conference – along with F.ounders curator Paddy Cosgrave, as a hub for startups and investors.

49 MARK READ

STRATEGY DIRECTOR, WPP AND CEO, WPP DIGITAL

▲(48)

Aiming to boost WPP's digital business from its 30 per cent share to 40 per cent in the next two years, Martin Sorrell's digital brain takes the future very seriously. Having overseen the folding of WPP's 18 digital brands into one giant agency, Possible Worldwide, last year, Read sums up the world's largest ad agency's strategy as being "China and the internet" with more focus on interactive film, mobile platforms and apps.

50 TOM HULME

DESIGN DIRECTOR, IDEO

▲(55)

A Young Global Leader of the World Economic Forum, Hulme helps others to build and develop innovative businesses and enterprises. OpenIDEO, the open innovation platform he launched in 2011, now has more than 30,000 users in more than 170 countries. Hulme speaks at conferences around the globe, including WIRED 2011, where he highlighted the need for "flexible systems" in businesses. He is an angel investor in Wonga and Fantasy Shopper.

51 HANS-ULRICH OBRIST

CO-DIRECTOR OF EXHIBITIONS AND PROGRAMMES, SERPENTINE GALLERY

▲(78)

Also in charge of international projects at the Serpentine, Obrist sits at the centre of the art world, connecting household names like Ai Weiwei and Zaha Hadid with a new generation of talent including Ed Fornieles and LuckyPDF. Obrist is expanding to a new gallery, due to open this summer in Kensington Gardens; Hadid is renovating the existing building there.

52 JK ROWLING

AUTHOR

★(NEW ENTRY)

In March this year she launched Pottermore.com, a website that augments the *Harry Potter* experience with additional stories, online games, e-book readings and a social network for fans to talk magic. More importantly, the site is the sole source for buying *Potter* e- and audio books – they can be "bought" via Amazon, but at the checkout, shoppers are redirected to pay at Pottermore, further driving traffic to the site. Magic.

53 SIMON PATTERSON

MANAGING DIRECTOR, SILVER LAKE

★(NEW ENTRY)

Patterson helps manage Silver Lake's private-equity investments in well-established tech firms such as Groupon, Zynga and Smart Storage Systems, which develops solid-state memory. In September 2009, Silverlake bought 70 per cent of Skype from eBay for $1.9bn. Fast-forward 18 months, and this value had tripled. Then in May 2011, Microsoft paid Silverlake $8.5bn for Skype. Not a bad profit.

54 NATALIE MASSENET

FOUNDER, NET-A-PORTER

▼(20)

Massenet had a busy 2011: she sold her remaining stake in the luxury e-tailer to Richemont for £50 million, and still found time to launch high-end menswear portal Mr Porter. She says that 20 per cent of Net-a-Porter sales are now done by mobile device, with this predicted to rise to 50 per cent next year. The big challenge for 2012: making inroads into the vastly lucrative £32 billion Chinese luxury-goods market.

55 ALASTAIR LUKIES

FOUNDER, MONITISE

★(NEW ENTRY)

The UK's mobile money pioneer continues to enjoy success. Currently, the nine-year-old Monitise has six million global users – a number growing at the rate of 150,000 per month – and a £14 million turnover in 2011. Expanding into new domains, Monitise launched a pilot scheme in Nigeria last year and a retail app with Charles Dunstone in the UK. Good thing he didn't stick with pro rugby.

56

ANDRE GEIM

PHYSICIST

★(NEW ENTRY)

Newly-knighted Sir Andre discovered (with colleagues) graphene – an ultra-strong nanosheet of carbon, which, at 200 times the strength of steel, could be used to make anything from solar panels to aircraft wings. In 2010 Geim and his colleague Konstantin Novoselov were awarded the Nobel Prize for Physics with reference to their "groundbreaking experiments regarding the two-dimensional material". Last October a so-called "graphene hub" – based around Manchester University, where Geim works – received £50 million worth of funding from the UK government. The collection of facilities focusing on graphene research aims to bring the 0.142 nanometre-thick material closer to commercial production and build an economy around it. Recent research has shown that graphene can make solar cells more efficient.

57 CHRISTIAN HERNANDEZ GALLARDO

DIRECTOR, PLATFORM PARTNERSHIPS, FACEBOOK EUROPE, MIDDLE EAST AND AFRICA

▼(16)

The London-based Salvadorean is tasked with driving Facebook's use by expanding its open graph to third parties and developing partnerships. As of September 2011, the former Microsoft and Google man has also been busy on Seedcamp's board of advisers.

58 CHARLIE MCDONNELL

YOUTUBE VLOGGER

★(NEW ENTRY)

McDonnell, 21, is Britain's biggest YouTube sensation: in June 2011 his channel Charlieissocoollike!!! was the first in the UK to reach a million subscribers, and has had 240m video views. It started with the video "How to get featured on YouTube", in 2007. By April this year, McDonnell had 1.4 million subscribers and was gaining 5,000 signups per week. His video, "Duet with Myself", has been viewed more than seven million times.

59 CHARLIE MCMURDIE

HEAD OF POLICE CENTRAL E-CRIME UNIT

★(NEW ENTRY)

A veteran of the Metropolitan Police, McMurdie currently heads Scotland Yard's e-crime unit, which she established in 2008. Last year, McMurdie's 85-strong team reported that they had prevented £140 million worth of cyber crime in the UK, at a cost of just £30 million of government funds. Number one on McMurdie's to-do list this year is tracking and stopping cyber crime leading up to the London 2012 Olympics.

60 CHRISTOPHER BAILEY

CHIEF CREATIVE OFFICER, BURBERRY

▼(32)

Bailey maintains Burberry's position as the luxury brand that best understands digital. It has recently launched Burberry Bespoke, an online store offering customisation of fashion through 12 million variations of trench coats. Bailey sees Burberry as a media-content company as much as a design house: the new London Regent Street flagship store opening this summer owes more to Apple than the catwalk.

61 ERIC VAN DER KLEIJ

CEO, TECH CITY INVESTMENT ORGANISATION

★(NEW ENTRY)

The man behind the UK government's blueprint for Tech City, van der Kleij founded the web-callback service RealCall before pivoting it into Adeptra, whose technology alerts users to potential credit-card fraud. He has been working on both sides of the Atlantic to bring entrepreneurs and investors to London, and also helped convince Loic Le Meur (22) to bring LeWeb to London this year.

13 MIKE BRACKEN

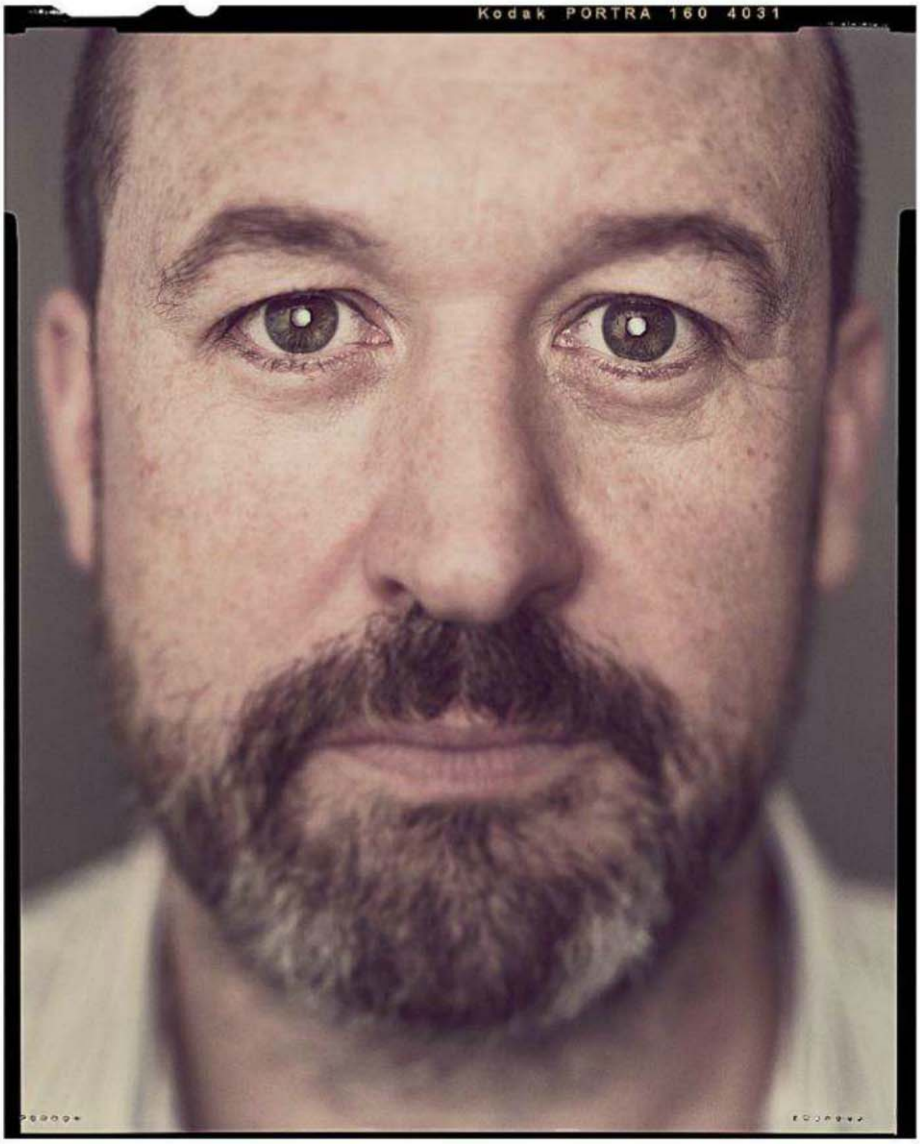
EXECUTIVE DIRECTOR DIGITAL EFFICIENCY, UK GOVERNMENT

★(NEW ENTRY)

On Bracken's watch as director of digital development at *The Guardian*, the paper's website reached 70 million visitors a month and more than 20 digital products were launched – from subscription-based apps to the MPs' expenses website. "Between 2009 and 2011 we put the platform in place for digital growth," he says. "We effectively created an open platform that allowed people to get involved." He left the paper last July with the aim of transforming the delivery of the government's digital services to become "digital by default".

The December launch of Government Digital Services (GDS) marked the official start of the shift, as conceptualised by Martha Lane Fox in a 2010 report to MPs. It aims to bring together the scattered parts of the "government digital estate" under the gov.uk umbrella; to fix the government's corporate publishing arm; to improve online transactions; and to open up government APIs. "Rather than basing the system on policy, we're basing it on delivery," says Bracken. "We're focusing on user experience."

Bracken, who helped set up e-democracy project MySociety, says the changes won't be completed for several years, with electoral registration reform only ready for the May 2015 general election. Fixing the outdated and highly bureaucratic system will be difficult, but changing the internal ideology has been the hardest. "A major point of friction has been getting [people] out of the mindset of 'we can't do this, that's what private businesses do.'" he says. "But there's no reason the government can't."



62 KRISTIAN SEGERSTRÅLE

EXECUTIVE VICE PRESIDENT, DIGITAL, ELECTRONIC ARTS

▼(26)

Since Electronic Arts's $400million acquisition of Playfish in 2009, the social-gaming platform's cofounder has been put in charge of launching some of EA's big-hitting franchises on Facebook, such as *The Sims Social*, which went live in August 2011, and now attracts over 17 million players a month. Not bad for a man who was told by his mum that if he didn't stop playing games, he'd never get a job.

63 WILLIAM REEVE

ANGEL INVESTOR

▲(100)

The founder of Fletcher Research and LOVEFiLM now manages Oxalyst, a new venture in the hedge-fund industry. Ex McKinsey man Reeve also sits on the boards of numerous online companies, including Graze.com, Paddy Power, Secret Escapes, True Knowledge and Zoopla. As well as investing, he helps students develop ideas for startups and advises established companies on VC, growth funding and exits.

64 BRIAN COX

TV PRESENTER, PROFESSOR OF PHYSICS, UNIVERSITY OF MANCHESTER

★(NEW ENTRY)

Prof Cox's ability to simplify science on mainstream television – his *Stargazing LIVE* had 3.62m viewers – and his radio show, *The Infinite Monkey Cage*, science books and even a film, have made him Britain's best known scientist. In March, he released *Wonders of the Universe* – a £4.99 app with 3D models of stars and galaxies, infographics and commentary.

65 ALEX HOYE

CEO, LATITUDE GROUP

▲(71)

Hoye has been championing London's "Silicon Roundabout", which he describes as London, LA, New York and Washington "all in one place". As an angel investor, he has funded about 20 startups including Skimlinks, MyBuilder, UserVoice, RentMineOnline, Seedcamp and Brave New Talent. His influence comes from his ICE entrepreneurs email list, which has evolved into ski and summer trips for networking. The last ski trip had more than 60 attending.

19

EILEEN BURBIDGE

COFOUNDER, WHITE BEAR YARD

★(NEW ENTRY)

Burbidge came to London from Silicon Valley in 2004 to lead the products team of a startup called Skype. Today, the cofounder of White Bear Yard and Passion Capital sits on the boards of Mendeley, Flattr and Stylistpick.

Stylistpick recommends user-specific clothes and accessories to its customers, selling them at a reduced rate. The company received £6.8 million in series B funding in February 2012, making a total of £11.7 million. For Burbidge, it's the personality behind a project that sways investment. "[Stylistpick] founder and CEO Felix Leuschner is a serial entrepreneur with amazing executional abilities," she says. "The company's success is a reflection of investors' interests in backing him."

After leaving Skype in 2007 Burbidge moved to Yahoo! before advising the Ambient Sounds Investments seed fund – a venture team of Skype engineers. In 2009, alongside Stefan Glaenzer and Robert Dighero, Burbidge set up White Bear Yard, a London hub for startups, digital technology and media companies. The team is also behind Passion Capital, which provides early-stage funding for tech firms. Since launching in 2011, Passion Capital has invested in over 20 startups, eight of which have gone on to receive further financing. "That's the traditional mark of success for a startup," says the angel investor whose 2012 portfolio includes Tripbirds and GoCardless.

66

IAN HOGARTH

CEO OF SONGKICK; ORGANISER, SILICON MILKROUNDABOUT

★(NEW ENTRY)

Hogarth studied machine learning at Cambridge University and worked as a DJ in China – now he's combining the two to predict which music concerts you'd like with Songkick, the gig-listing site he cofounded in 2007. In 2011, the site's monthly visitors grew 1,000 per cent; the east London startup's new app on Spotify delivered 100,000 new users. The site now receives five million monthly visitors and its iPhone app was downloaded 100,000 times in ten days last summer. Songkick makes money by linking to ticket vendors, then taking between two and ten per cent of any transaction. The numbers convinced Sequioa Capital – the Silicon Valley VC firm whose other investments have included Apple, Dropbox, Google, LinkedIn and Square – to invest $10 million this March (its first UK investment), on top of the existing backing from Index Ventures.

Hogarth is also taking the lessons he learnt at American incubator Y Combinator (which backed the company with $15,000) and applying them to London by organising Silicon Milkroundabout, a recruitment fair for startups. The two events last year attracted 1,786 tech job seekers and filled 168 posts at 113 startups. This year it's expanding to Cambridge.

67 JACK SCHULZE, MATT JONES & MATT WEBB

PRINCIPALS, BERG

▲(70)

The interactive design innovators continue to domesticate tech with human-friendly interfaces. They recently created Little Printer, a household gadget that prints a customised bite-size daily newspaper, with content sourced from across the web. Add that to iPad magazines, receipts redesigned as infographics and a graphic novel that reveals itself under UV light, and it's no surprise that Steve Jobs was a fan.

68 JAMAL EDWARDS

FOUNDER, SBTV

★(NEW ENTRY)

Jamal Edwards launched SB.TV (smokeybarz), an online music channel on YouTube, dedicated at the time to grime artists in his native west London, when he was 15. It has since had 100 million YouTube views and claims to be its leading UK youth channel. Edwards, 21, is based in London and now also runs his own music label, Just Jam Records (an imprint of Sony RCA). He has featured on adverts for Google Chrome. Next up: New York.

69 RORY CELLAN-JONES

BBC NEWS TECHNOLOGY CORRESPONDENT

▼(40)

As the main technology writer and reporter on BBC News, Cellan-Jones is the face of tech to many of the Beeb's 14 million monthly website visitors and is frequently on TV news and radio. He tends to follow trends rather than break stories, yet as "the non-geek's geek" he commands two popular accounts on Twitter – his official BBC handle with 26,000 followers and his personal account with more than 42,000.

70 SAM & DAN HOUSER

COFOUNDERS, ROCKSTAR GAMES

★(NEW ENTRY)

Rockstar, set up by the Houser brothers, made its name with the tabloid newspaper-baiting *Grand Theft Auto* series, but more recent releases such as *Red Dead Redemption*, *Max Payne 3* and *L.A. Noire* have confirmed it as one of the most creative and commercially successful video-game studios around. The publicity-shy brothers return to the fray, co-writing the forthcoming *Grand Theft Auto V*.

71 WARREN EAST

CEO, ARM HOLDINGS

▼(15)

Chief of the Cambridge-based microprocessor company, whose chips are now in about 99 per cent of all smartphones, East says he is just getting started. In 2011, 7.9bn ARM chips were shipped, nearly twice as many as the previous year. The company's revenue last quarter jumped 21 per cent from a year earlier and the soon-to-be-released Windows 8 OS will run on ARM chips for the first time.

72 ALEX VAN SOMEREN

PARTNER, AMADEUS CAPITAL PARTNERS

▲(93)

The entrepreneur and VC runs a £10 million seed-capital fund for Amadeus Capital. In April, as non-executive chairman of oneDrum – a startup providing tools for workers to collaborate in real time on Microsoft Office applications – he helped to negotiate the six-month-old company's acquisition by US-based social network Yammer. He also helped to draft the UK's entrepreneur-visa legislation.

73 DANIEL WATERHOUSE

PARTNER, WELLINGTON PARTNERS

▼(62)

An alumnus of Yahoo!, Waterhouse specialises in digital media, and has a track record of investing in smart startups and services including Qype (local reviews), Spotify (music), Artfinder (art identification and sales) and GameDuell (gaming communities). He recently joined the board of *Hailo*, a cab-calling app for smartphones. Backed by Accel, the service is expanding to the US.

74 CHRISTOPHER NORTH

MANAGING DIRECTOR, AMAZON UK

★(NEW ENTRY)

Under North's guidance, Amazon.co.uk set a record of three million transactions on a single day in December 2011 (up from 2.3 million the year before). The Kindle Fire and the expansion of LOVEFiLM will further extend North's reach. North is also part of Business for New Europe, a coalition of business leaders who seek to promote the benefits of UK membership of the European Union.

75 JOE COHEN

FOUNDER AND CEO, SEATWAVE

★(NEW ENTRY)

Despite losses of several million in 2010, Cohen has bounced back in 2011. The Seatwave CEO and founder handled a minor television scandal well, set up a real-time ticketing shop in London and released a software developers' kit for Apple's iOS. With a bunch of new APIs, Seatwave is gradually integrating its ticketing services into the global e-marketplace.

76 IMRAN AMED

FOUNDER AND EDITOR, THE BUSINESS OF FASHION

★(NEW ENTRY)

Amed has a knack for spotting fashion's creative and commercial possibilities. His expertise is sought by labels keen to learn how to develop digital strategies. An associate lecturer at Central St Martin's College, he sits on the British Fashion Council's Digital and Fashion 2012 Menswear Committees and on the board of Dasra, India's strategic philanthropy foundation.

77 DAVID BOTT

DIRECTOR, INNOVATION PROGRAMMES, TECHNOLOGY STRATEGY BOARD

▼(47)

Bott has overseen the £200 million series of "Catapult" virtual innovation and technology centres, that link government, business and academia. High-value manufacturing centres opened in 2011; cell therapy and satellite are expected this year; transport systems, offshore renewables and future cities are slated for 2013.

78 TOM WATSON

MP; DEPUTY CHAIR, LABOUR PARTY

★(NEW ENTRY)

Deputy chair of the Labour Party, Watson made more effective use of social media than other politicians during the unfurling Murdoch phone-hacking scandal. He recently released a book on the topic, *Dial M for Murdoch*, co-authored with Martin Hickman. Watson tweets frequently to 80,000 followers and has been a vocal campaigner on digital issues and opening up government data.

79 JUSTIN COOKE

CEO, FORTUNE COOKIE

★(NEW ENTRY)

The founder of digital marketing and design agency Fortune Cookie, Cooke has been chairman of the British Interactive Media Association, the industry body for digital Britain, since 2009. Fortune Cookie – which has clients that include American Express and BP – developed a real-time mobile web platform for National Rail Enquiries to keep users up to date. It has offices in London, New York, Melbourne and Chorzów in Poland.

80 ANDREW BLAKE

MANAGING DIRECTOR, MICROSOFT RESEARCH, CAMBRIDGE

★(82)

Leading a team of four, computer engineer Blake solved some of the mathematical challenges that made real-time motion tracking possible; it helped Kinect become the fastest selling consumer device in history. The ex-academic and fellow of the Royal Academy of Engineering also worked on KinectFusion, a technology that could benefit the medical, defence and gaming industries.

81 BINDI KARIA

VC AND EMERGING BUSINESS LEAD, MICROSOFT UK GROUP

▼(39)

A well-connected and friendly adviser to early-stage startups, Karia is a hugely influential figure for early-stage tech companies. More than 45,000 startups around the world have joined Microsoft's BizSpark programme for support and networking. Karia is also the UK member of the Silicon Valley Emerging Business Team and sits on several tech advisory boards, including that of Seedcamp.

82 JUDITH CLEGG

FOUNDER, THE GLASSHOUSE

▲(77)

Clegg founded The Glasshouse, which runs networking events for entrepreneurs, during the first dotcom boom. Now, she's taking on McKinsey by setting up Takeout – a boutique consultancy that taps the experience of entrepreneurs instead of MBAs, with offices in London and New York. Clients include Barclaycard, Microsoft and YO Sushi! But a planned investment fund with Anil Hansjee was recently dropped.

83 TBG DIGITAL

ONLINE ADVERTISING AGENCY

★(NEW ENTRY)

One of the first agencies to jump on Facebook's Ads API in August 2011, award-winning TBG Digital has been busy this past year. The London-based agency specialises in Facebook ad campaigns in 40 countries, and has built its own Facebook-specific ad optimisation software for the likes of Vodafone, Dell and Heineken. TBG is reportedly responsible for just under ten per cent of all advertising bought on Facebook.

84 CLARE REDDINGTON

DIRECTOR, ISHED AND THE PERVASIVE MEDIA STUDIO

▼(73)

Reddington's Bristol design studio iShed connects creative disciplines: it recently funded six companies to create radical new apps for historic sites and museums. Next, it will encourage another six companies to work with academics to create "something better than an ebook". Reddington is also curating programmes in Guimarães, the European Capital of Culture in 2012, and organising artist swaps with Japan and Brazil.

85 ANDY NELSON

CHIEF INFORMATION OFFICER, UK GOVERNMENT

★(NEW ENTRY)

Since taking on the role of government CIO alongside his existing job of Ministry of Justice CIO in March, Nelson has been tasked with leading the government's ICT strategy. With 30 years' experience in IT at Royal Sun Alliance and as director of computer services at Asda, Nelson left the private sector and joined the MoJ in 2009. He has been involved in the Coalition's G-Cloud plans since early 2011.

86 SHAKIL KHAN

HEAD OF SPECIAL PROJECTS, PATH

★(NEW ENTRY)

Khan has moved on from four years as Spotify's head of special projects to do the same job at Path – the fast-growing social networking startup based in San Francisco. At Spotify Khan played a significant role in the company's entry and fast expansion in the US market in 2011, and was a key adviser to CEO Daniel Ek. For Path, he will manage international growth from London, remaining an investor in and adviser to Spotify.

87

CHRIS LINTOTT

ASTROPHYSICIST, UNIVERSITY OF OXFORD

★(NEW ENTRY)

Astrophysicist Lintott joins Brian Cox as a scientist who has crossed the pop-cultural divide. He discovered the power of crowdsourced science in 2007, when he asked online for help to classify a million galaxies into distinct shapes. Galaxy Zoo got 100,000 responses on the first day, prompting other UK scientists to contact Lintott for help. The result was an expanded hosting platform for citizen scientists to deal with data overflow. Called Zooniverse, it allows people to classify galaxies, hunt for planets, ascertain whether whales have accents, and transcribe ancient papyri. In January, Lintott, asked BBC viewers to analyse live images from Nasa's Kepler telescope – they found three new planets, including one where liquid water could exist. In April, Zooniverse had 600,000 users.

88 CHRISTOPHER GREW

PARTNER, ORRICK

▼(75)

Qualified barrister Grew holds a key role in Orrick's Emerging Companies group, which advises startups and VC firms. He consults tech companies on international operations and investments, remains an active participant in Seedcamp – both as a mentor and a judge – and represents many of Seedcamp's companies including EDITD, Smarkets and Wishdate. Recently, he has become interested in the startup talent in Russia.

89 EMMA MULQUEENY

DIRECTOR AND COFOUNDER, REWIRED STATE AND YOUNG REWIRED STATE

★(NEW ENTRY)

Mulqueeny is behind Rewired State and Young Rewired State – independent developers who rapidly code innovative software using open data. The UK government and industry use the developers' work to improve services such as UCAS and lobbying. The non-profit has 600 adults and 500 under-18 coders in the UK, with plans for Australia, Europe and the US.

90 ED VAIZEY

MP, MINISTER FOR CULTURE, COMMUNICATIONS AND CREATIVE INDUSTRIES

▼(18)

Vaizey is overseeing the Digital Economy Act, likely to come in later this year. In February he announced a £180 million investment in Freeview – from cash raised by auctioning 4G bandwidth – and stopped Everything Everywhere getting an early start on the other UK telcos. He wants coding classes to be compulsory in UK schools.

91 JEREMY MYERSON

DIRECTOR AND CHAIR, HELEN HAMLYN CENTRE FOR DESIGN, ROYAL COLLEGE OF ART

▼(81)

An influential thinker and consultant, Myerson's remit at the RCA is to encourage "design that improves the quality of life", a virtue he extols at speaking engagements. He is on the selection panel of the International Council of Societies of Industrial Design – its designated World Design Capital 2014 is Cape Town.

92 TOM STANDAGE

DIGITAL EDITOR, *THE ECONOMIST*

▼(72)

Standage – managing iOS and Android editions – has helped the weekly to hit record global circulation: more than 1.5 million subscribers and 127,000 readers on iPad. At that rate of growth, it will probably surpass *The New Yorker*'s 1.6 million global audience in 2012. He also edits *The Economist Technology Quarterly*. Standage has written for *The Daily Telegraph*, *The Guardian* and WIRED.

93 RENE RECHTMAN

SENIOR VICE PRESIDENT ADVERTISING, AOL, EUROPE, MIDDLE EAST AND AFRICA

▼(45)

Rechtman joined AOL in 2011 when it bought his online video-distribution agency GoViral. He steered the European growth of the AOL Advertising group, and in Q3 of 2011, AOL's global ad sales rose eight per cent, partly thanks to a 28 per cent rise in ads sold through advertising.com. Rechtman is also an active angel investor.

94 ANDREW FISHER

CEO, SHAZAM

▼(59)

Since 2005, Fisher has detemined Shazam's strategic focus. In 2011, the hit audio-recognition app focused on the US, expanding into enabling deeper engagement for viewers of adverts and television programmes – viewers can now "Shazam" for extra content. In the US, half of all Super Bowl XLVI adverts were *Shazam*-enabled; in the UK, the firm has partnered with ITV to offer the service to advertisers keen to reach Britain's ten million *Shazam* users.

95 COLLETTE BALLOU

FOUNDER, BALLOU PR

■(95)

Last November, Ballou sold the US operations of her eponymous tech PR firm to MWW Group for an undisclosed amount. The company still has offices in London and Paris, and Ballou herself is a mentor at Dave McClure's 500 Startups. She forms one half of a London tech power couple currently flush with cash: partner Max Niederhofer recently sold his own company, social-search engine Qwerly, to Fliptop, a competitor service based in San Francisco.

96 ANDREW MILLER

CEO, GUARDIAN MEDIA GROUP

▼(87)

Recent Audit Bureau of Circulation figures put *The Guardian*'s website at almost 70m unique browsers during February 2012; *The Guardian* Facebook app, launched last September, has been downloaded more than eight million times. It's a huge reach, but the paper is weakened by its long-running losses, and a strong web and social presence hasn't yet paid the bills. Miller has his work cut out to turn these clicks into cash.

97 LEE CHILD

KINDLE KING

★(NEW ENTRY)

After falling foul of corporate TV restructuring in the 90s, Coventry-born Lee Child (real name Jim Grant) dusted himself down and got to work writing his first novel. *Killing Floor*, the first in his Jack Reacher series, was a hit, and 16 books later he has become the Kindle's most successful British author, outselling even Jane Austen. Tom Cruise is playing Reacher in a Hollywood film adaptation of *One Shot*, directed by Christopher McQuarrie.

98 MILO YIANNOPOULOS

PROVOCATEUR, THE KERNEL

▼(84)

Tech's gadfly continues to provoke and irritate, often for its own sake. His influence has waned since losing his *Telegraph* column, but his latest venture, *The Kernel*, has given him new power to torment. It's a low-budget project, but its weekly *Nutshell*, a gossipy, legally uncautious newsletter, picks publicly on targets such as the government's Tech City initiative. Unlikely to be a sustainable model, but he's much talked about.

99 ED YONG

WRITER AND SCIENCE JOURNALIST

★(NEW ENTRY)

Yong's list of awards – one of his stories was published in *Best American Science Writing 2011* – shows what the 300,000 people who read his blog, Not Exactly Rocket Science, already know: Yong is one of the sharpest science writers out there. Daily tweets to his 19,000 followers demonstrate that this occasional WIRED writer is building a serious credibility as a science communicator.

100 MICHAEL BIRCH

INVESTOR

▼(53)

Birch's San Francisco mansion is a home-from-home for British web entrepreneurs; it even has a replica pub. To support his favoured non-profit, charity: water, his latest scheme is to raise millions of dollars using social media and viral online networks. The Bebo cofounder and CEO of Monkey Inferno continues to invest the proceeds of the $850 million sale to AOL. He recently backed ResearchGate, a professional network for scientists.

59

CHARLIE MCMURDIE

HEAD OF POLICE CENTRAL E-CRIME UNIT

★(NEW ENTRY)

A veteran of the Metropolitan Police, McMurdie heads up Scotland Yard's cyber-crime unit, which she set up in 2008. Her role has never been more central to crimefighting: last year, the government said cyber crime cost the UK economy £27bn. McMurdie's 30-year career as a specialist crime detective spans covert operations to murder investigations, the Flying Squad and founding the Stolen Vehicles Unit. "In all the places I worked, I realised no one was taking on cyber crime," says McMurdie, 50. "E-crime is borderless, so in 2008, I put a case together calling for a new national unit."

With initial funding from the Home Office, she assembled a small task force and set about busting online crime with the help of major banks. In September 2011, McMurdie's 85-strong team reported that they prevented £140 million worth of cyber crime in the UK in the preceding six months, using just £30 million of government funds. "The target set for us by Home Office last April was to prevent £504 million worth of harm in four years," McMurdie says. "We will probably deliver that within year one."

In July, she will be managing a team of approximately 5,000 staff monitoring potential cyber attacks on the London Olympics, while conducting about 30 ongoing investigations into data crimes. According to McMurdie, she has found her calling. "I've never been as hands-on as I am with cyber," she says. "There are constant new challenges."

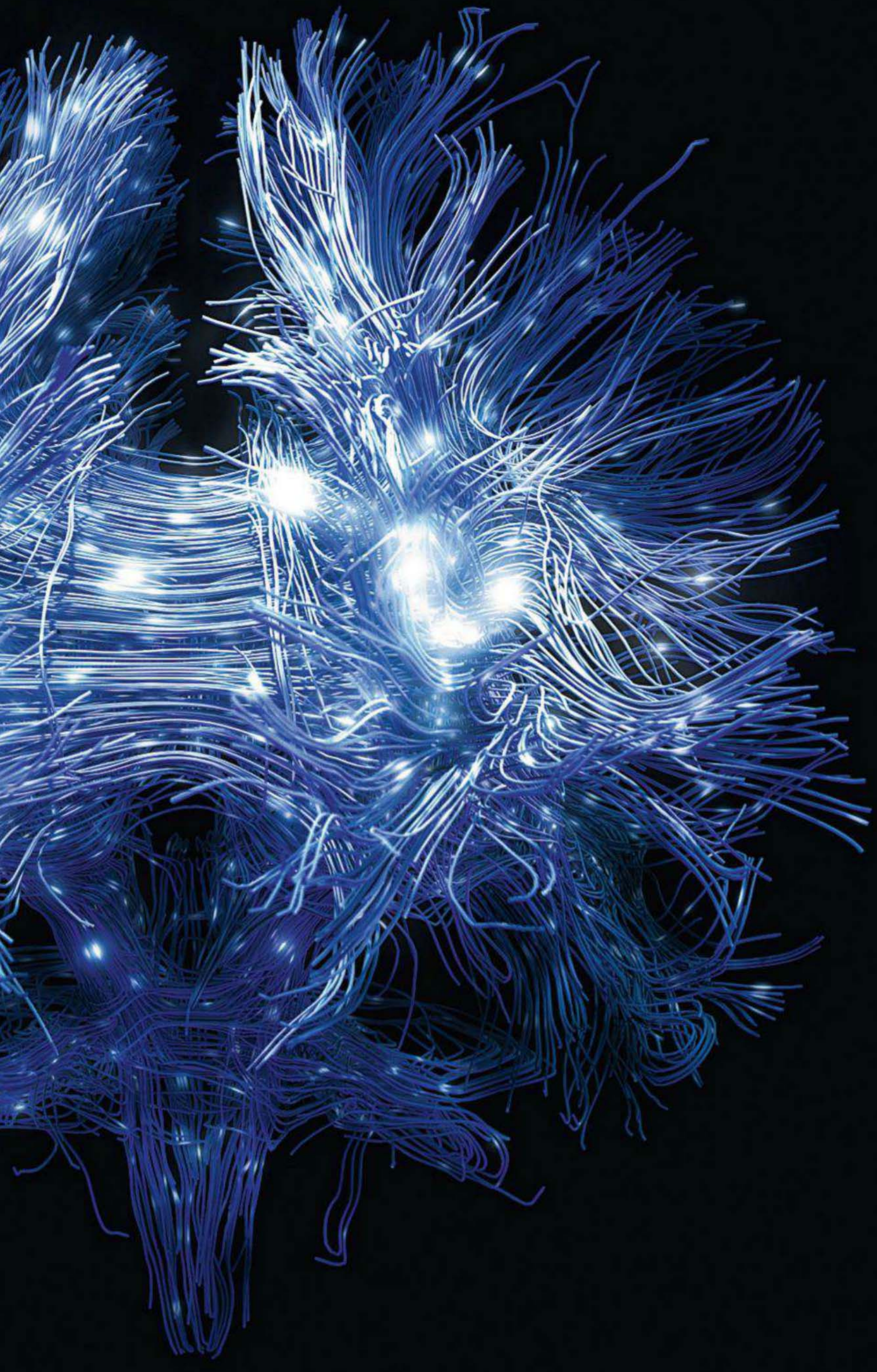
Sebastian Seung is a neuroscientist with a bold new theory on how brain connections make us who we are. Mapping the brain, neuron by neuron, may reveal how our experiences affect our mental wiring

The connectome

By Sebastian Seung

Imagery by the Laboratory of Neuro Imaging, UCLA, Carlos Mena and Arthur W Toga

A VISUALISATION OF HUMAN BRAIN ACTIVITY, BASED ON DATASETS FROM SEVERAL HUMAN SUBJECTS. THE WIRES SHOW CONNECTIVITY IN THE BRAIN AT A MACRO LEVEL



Measured by diffusion spectral imaging, the fibres of white matter show the architecture of the brain, whereas the coloured fibres are coded by direction

No road, no trail can penetrate this forest. The long and delicate branches of its trees lie everywhere, choking space with their exuberant growth. No sunbeam can fly a path tortuous enough to navigate the narrow spaces between these entangled branches. All the trees of this dark forest grew from 100 billion seeds planted together. And, all in one day, every tree is destined to die.

This forest is majestic, but also comic and even tragic. It is all of these things. Indeed, sometimes I think it is everything. Every novel and every symphony, every cruel murder and every act of mercy, every love affair and every quarrel, every joke and every sorrow – all these things come from the forest.

You may be surprised to hear that it fits in a container less than 30 centimetres in diameter. And that there are seven billion on this Earth. You happen to be the caretaker of one, the forest that lives inside your skull. The trees of which I speak are those special cells called neurons. The mission of neuroscience is to explore their enchanted branches – to tame the jungle of the mind. Neuroscientists have eavesdropped on its sounds, the electrical signals inside the brain. They have revealed its fantastic shapes with meticulous drawings and photos of neurons. But from just a few scattered trees, can we hope to comprehend the totality of the forest?

In the 17th century, the French philosopher Blaise Pascal confessed that he was terrified by the vastness of the universe. Pascal meditated upon outer space, but we need only turn our thoughts inward to feel his dread. Inside every one of us lies an organ so vast in its complexity that it might as well be infinite.

As a neuroscientist I have come to know first-hand Pascal's dread. I have also felt embarrassment. Sometimes I speak to the public about the state of our field. After one such talk I was pummelled with questions. What causes depression and schizophrenia? What is special about the brain of an Einstein or a Beethoven? How can my child learn to read better? As I failed to give satisfying answers, I could see faces fall. I finally apologised. "I'm sorry," I said. "You thought I'm a professor because I know the answers. Actually I'm a professor because I know how much I don't know."

Studying an object as complex as the brain may seem almost futile. The brain's billions of neurons resemble trees of many species and come in many fantastic shapes. Only the most determined explorers can hope to capture a glimpse of this forest's interior, and even they see little, and see it poorly. It's no wonder that the brain remains an enigma. My audience was curious about brains that malfunction or excel, but even the humdrum lacks explanation. Every day we recall the past, perceive the present, and imagine the future. How do our brains accomplish these feats? It's safe to say that nobody really knows.

Daunted by the brain's complexity, many neuroscientists have chosen to study animals with drastically fewer neurons than humans. The worm lacks what we'd call a brain. Its neurons are scattered throughout its body rather than centralised in a single organ. Together they form a nervous system containing a mere 300 neurons. That sounds manageable. Every neuron in this worm has been given a unique name and has a characteristic location and shape. Worms are like precision machines mass-produced in a factory: each one has a nervous system built from the same set of parts, and the parts are always arranged in the same way.

What's more, this standardised nervous system has been mapped completely. The result is something like the flight maps we see in the back pages of airline magazines. The four-letter name of each neuron is like the three-letter code for each of the world's airports. The lines represent connections between neurons, just as lines on a flight map represent routes between cities. We say that two neurons are "connected" if there is a small junction, called a synapse, at a point where the neurons touch. Through the synapse one neuron sends messages to the other.

Engineers know that a radio is constructed by wiring together electronic components like resistors, capacitors and transistors. A nervous system is likewise an assembly of neurons, "wired" together by their slender branches. That's why the map was originally called a wiring diagram. More recently, a new term has been introduced – connectome.

This word invokes not electrical engineering but the field of genomics. DNA is a long molecule resembling a chain. The individual links of the chain are small molecules called nucleotides, which come in four types denoted by the letters A, C, G and T. Your genome is the entire sequence of nucleotides in your DNA, or equivalently a long string of letters drawn from this four-letter alphabet. With three billion letters it would be a million pages long if printed as a book. In the same way, a connectome is the totality of connections between the neurons in a nervous system. The term, like genome, implies completeness. A connectome is not one connection, nor even many. It is all of them. In principle, your brain could also be summarised by a diagram that is like the worm's, though much more complex. Would your connectome reveal anything interesting about you?

The first thing it would reveal is that you are unique. You know this, of course, but it has been surprisingly difficult to pinpoint where, precisely, your uniqueness resides. Your connectome and mine are very different. They are not standardised like those of worms. That's consistent with the idea that every human is unique in a way that a worm is not.

Differences fascinate us. When we ask how the brain works, what mostly interests us is why the brains of people work so differently. Why can't I be more outgoing, like my extroverted friend? Why does my son find reading more difficult than his classmates do? Why is my teenage cousin starting to hear imaginary voices? Why is my mother losing her memory? Why can't my spouse (or I) be more compassionate and understanding?

I propose a simple theory: minds differ because connectomes differ. Personality and IQ might also be explained by connectomes. Perhaps even your memories, the most idiosyncratic aspect of your personal identity, could be encoded in your connectome.

Although this theory has been around a long time, neuroscientists still don't know whether it's true. But clearly the implications are enormous. If it's true, then curing mental disorders is ultimately about repairing connectomes. In fact, any kind of personal change – educating yourself, drinking less, saving your marriage – is about changing your connectome.

But let's consider an alternative theory: minds differ because genomes differ. In effect, we are who we are because of our genes. The new age of the personal genome is dawning. Soon we will be able to find our own DNA sequences quickly and cheaply. We know that genes play a role in mental disorders and contribute to normal variation in personality and IQ. Why study connectomes if genomics is already so powerful?

The reason is simple: genes alone cannot explain how your brain got to be the way it is. As you lay nestled in your mother's womb, you already possessed your genome but not yet the memory of your first kiss. Your memories were acquired during your lifetime, not before. Some of you can play the piano; some can ride a bicycle. These are learned abilities rather than instincts programmed by the genes.

Unlike your genome, which is fixed from the moment of conception, your connectome changes throughout life. Neuroscientists have already identified the basic kinds of change. Neurons adjust, or "reweight", their connections by strengthening or weakening them. Neurons reconnect by creating and eliminating synapses, and they rewire by growing and retracting branches. Finally, entirely new neurons are created and existing ones eliminated, through regeneration.

We don't know exactly how life events – your parents' divorce, your fabulous year abroad – change your connectome. But there is good evidence that all four Rs – reweighting, reconnection, rewiring and regeneration – are affected by your experiences. At the same time, the four Rs are also guided by genes. Minds are indeed influenced by genes, especially when the brain is "wiring" itself up during infancy and childhood.

Both genes and experiences have shaped your connectome. We must consider both historical influences if we want to explain how your brain got to be the way it is. The connectome theory of mental differences is compatible with the genetic theory, but it is far richer and more complex because it includes the effects of living in the world. The connectome theory is also less deterministic. There is reason to believe that we shape our own connectomes by the actions we take, even by the things we think. Brain wiring may make us who we are, but we play an important role in wiring up our brains.

To restate the theory more simply:

You are more than your genes. You are your connectome.

If this theory is correct, the most important goal of neuroscience is to harness the power of the four Rs. We must learn what changes in the connectome are required for us to make the behavioural changes we hope for, and then we must develop the means to bring these changes about. If we succeed, neuroscience will play a profound role in the effort to cure mental disorders, heal brain injuries and improve ourselves.

Given the complexity of connectomes, however, this challenge is truly formidable. Mapping the roundworm's nervous system took over a dozen years, though it contains only 7,000 connections. Your connectome is 100 billion times larger, with a million times more connections than your genome has letters. Genomes are child's play compared with connectomes.

Today our technologies are finally becoming powerful enough that we can take on the challenge. By controlling sophisticated microscopes, our computers can now collect and store huge databases of brain images. They can also help us analyse the torrential flow of data to map the connections between neurons. With the aid of machine intelligence, we will finally see the connectomes that have eluded us for so long.

I am convinced that it will become possible to find human connectomes before the end of the 21st century. First we'll move from worms to flies. Later we'll tackle mice, then monkeys. And finally we'll take on the ultimate challenge: an entire human brain. Our descendants will look back on these achievements as nothing less than a scientific revolution.

Do we really have to wait decades before connectomes tell us something about the human brain? Fortunately, no. Our technologies are already powerful enough to see the connections in small chunks of brain, and even this partial knowledge will be useful. In addition, we can learn a great deal from mice and rats, our close evolutionary cousins. Their brains are quite similar to ours and are governed by some of the same principles of operation. Examining their connectomes will shed new light on our brains as well as theirs.

In the year AD79, Mount Vesuvius erupted with terrifying fury, burying the Roman town of Pompeii under tons of volcanic ash and lava. Frozen in time, Pompeii lay waiting for almost two millennia until it was accidentally rediscovered by construction workers. When archaeologists began to excavate the city in the 18th century, they discovered to their amazement a detailed snapshot of the life of a Roman town – luxurious holiday villas of the wealthy, street fountains and public baths, bars and brothels, a bakery and a market, a gymnasium and theatre, frescoes depicting daily life, and phallic graffiti everywhere. The dead city was a revelation to historians, giving insight into the minutiae of Roman life.

Today we can conceive of finding connectomes only by analysing images of dead brains. You could think of this as brain archaeology, but it's more conventionally known as neuroanatomy. Generations of neuroanatomists have gazed at the cold corpses of neurons in their microscopes and tried to imagine the past. A dead brain, its molecules fastened in place by embalming fluid, is a monument to the thoughts and feelings that once lived inside. Until now, neuroanatomy resembled the act of reconstructing an ancient civilisation from the fragmentary evidence of coins and tombs and pottery shards. But connectomes will be detailed snapshots of entire brains, like Pompeii stopped in its tracks. These snapshots will revolutionise the neuroanatomist's ability to reconstruct the functioning of the living brain.

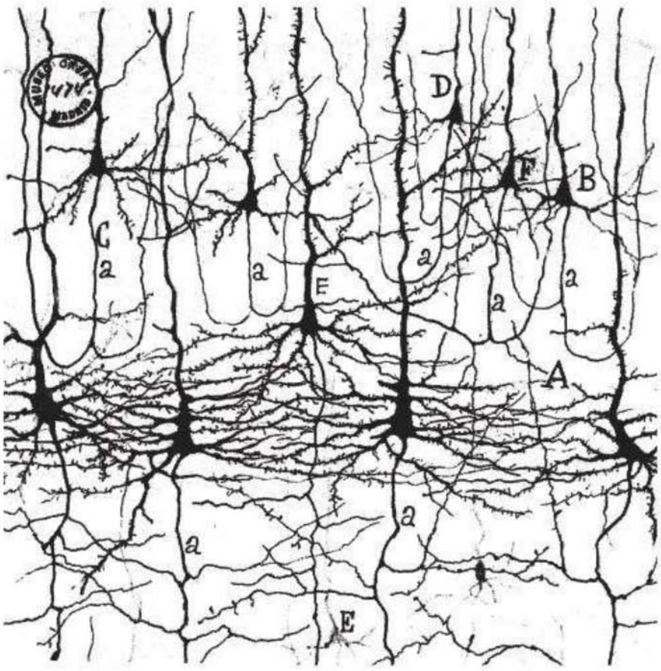
But why study dead brains when there are technologies for studying live ones? Wouldn't we learn more if we could travel back in time and study a living Pompeii? Not necessarily. To see why not, imagine some limitations on our ability to observe the living town. Let's say we could watch the actions of a single citizen but would be blind to all other inhabitants. Or, let's say we could look at infrared satellite images revealing the average temperature of each neighbourhood, but could not see finer details. With such constraints, studying the living town might turn out to be less illuminating than we'd hoped.

Our methods for studying living brains have similar limitations. If we open up the skull, we can see the shapes of individual neurons and measure their electrical signals, but what's revealed is only a tiny fraction of the billions of neurons in the brain. If we use non-invasive imaging methods for penetrating the skull and showing us the brain's interior, we can't see individual neurons; we must settle for coarse information about the shape and activity of brain regions. We can't rule out the possibility that some advanced technology of the future will remove these limitations and enable us to measure the properties of every single neuron inside a living brain, but for now it's just a fantasy. Measurements of living and dead brains are complementary, and the most powerful approach, in my view, combines them.

Many neuroscientists don't agree with the idea that dead brains can be informative and useful, however. Studying living brains is the only true way of doing neuroscience, they say, because:

You are the activity of your neurons.

Here "activity" refers to the electrical signalling of neurons. Measurements of these signals have provided ample evidence that the neural activity in your brain at any given moment encodes your thoughts, feelings and perceptions in that instant.



Neurons of the cerebral cortex stained by the method discovered by Camillo Golgi in 1873. They were then drawn by Santiago Ramón y Cajal, himself a neuroanatomist

How does the idea that you are the activity of your neurons square with the notion that you are your connectome? Although the two claims might at first glance seem contradictory, they are in fact compatible, because they refer to two different notions of the self. One self changes rapidly from moment to moment, becoming angry and then cheering up, thinking about the meaning of life and then the household chores, watching the leaves fall outside and then the football match on television. This self is the one intertwined with consciousness. Its protean nature derives from the rapidly changing patterns of neural activity in the brain.

The other self is much more stable. It retains memories from childhood over an entire lifetime. Its nature – what we think of as personality – is largely constant, a fact that comforts family and friends. The properties of this self are expressed while you are conscious, but they continue to exist during unconscious states like sleep. This self, like the connectome, changes only slowly over time. This is the self invoked by the idea that you are your connectome.

Historically, the conscious self is the one that has attracted the most attention. In the 19th century, the American psychologist William James wrote eloquently of the stream of consciousness, the continuous flow of thoughts through the mind. But James failed to note that every stream has a bed. Without this groove in the earth, the water would not know in which direction to flow. Since the connectome defines the pathways along which neural activity can flow, we might regard it as the stream bed of consciousness.

The metaphor is a powerful one. Over a long period, in the same way that the water of the stream slowly shapes the bed, neural activity changes the connectome. The two notions of the self – as both the fast-moving, ever-changing stream and the more stable but slowly transforming stream bed – are thus inextricably linked and suggest a new field of science: connectomics.

But we cannot chart the neuroscience of the future until we understand where we came from. What do we already know, and where are we stuck? The brain contains 100 billion neurons, a fact that has overwhelmed even the most fearless explorers. One solution to the problem of these kinds of overwhelming numbers is to forget about neurons and instead divide the brain into a small number of regions. Neurologists have learned much about the functions of these regions by interpreting the symptoms of brain damage. In developing this method, they were inspired by the 19th century school of thought known as phrenology.

Phrenologists explained mental differences as arising from variations in the sizes of the brain and its regions. By imaging the brains of many human subjects, modern researchers have confirmed this idea, using it to explain variations in levels of intelligence as well as mental disorders such as autism and schizophrenia. They have found some of the strongest evidence we have for the idea that minds differ because brains differ. The evidence is statistical, however – the results revealed only by averages over populations. The size of the brain and its regions remain almost useless for predicting the mental properties of an individual.

This limitation is no mere technicality. It is fundamental. Although phrenology assigns functions to brain regions, it does not attempt to explain how each region performs its function. Without that, we cannot explain in a satisfying way why the region might function especially well in some people and malfunction in others. We can, and must, find a less superficial answer than size.

There is an alternative to phrenology – connectionism – that also dates back to the 19th century. This approach is more ambitious because it attempts to explain how regions of the brain actually work. Connectionists view a brain region not as an elementary unit but as a complex network composed of many neurons. The connections of the network are organised so that its neurons can collectively generate the intricate patterns of activity that underlie our perceptions and thoughts. The organisation of connections can be altered by experience, which allows us to learn and remember. The organisation is also shaped by genes so that genetic influences on the mind can also be explained.

These ideas may sound powerful, but there is a catch: they have never been subjected to conclusive experimental tests. Connectionism, despite its intellectual appeal, has never managed to become real science, because neuroscientists have lacked good techniques for mapping the connections between neurons. In a nutshell, neuroscience has been saddled with a dilemma: the ideas of phrenology can be empirically tested but are simplistic. Connectionism is far more sophisticated, but its ideas cannot be evaluated experimentally. How do we break out of this impasse? The answer is to find connectomes and learn how to use them.

We are already starting to develop technologies for finding connectomes. But once we find them, what will we do with them? First, we'll use them to carve the brain into regions, aiding the work of neo-phrenologists. And we'll divide the enormous number of neurons into types, much as botanists classify trees into species. This will dovetail with the genomic approach to neuroscience, because genes exert much of their influence on the brain by controlling how neuron types wire up with each other.

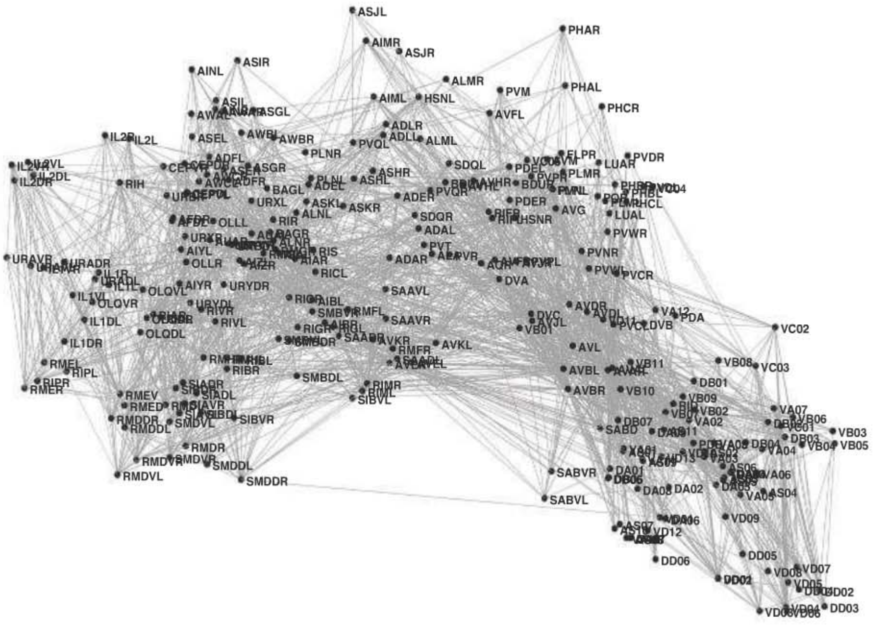
Connectomes are like vast books written in letters that we barely see, in a language that we do not yet comprehend. Once our technologies make the writing visible, the next challenge will be to understand what it means. We'll learn to decode what is written in connectomes by attempting to read memories from them. This endeavour will at long last provide a conclusive test of connectionist theories. But it won't be enough to find a single connectome. We will want to find many connectomes and compare them, to understand why one mind differs from another, and why a single mind changes over time. We'll hunt for connectopathies, abnormal patterns of neural connectivity that might underlie mental disorders such as autism and schizophrenia. And we'll look for the effects of learning on connectomes.

Armed with this knowledge, we will develop new methods of changing connectomes. The most effective way at present is the traditional one: training our behaviours and thoughts. But learning regimens will become more powerful when supplemented by molecular interventions that promote the four Rs of connectome change. The new science of connectomics will not be established overnight. Today we can only see the beginning, and the many barriers that lie in the way. Nevertheless, over the coming decades, the march of our technologies and the understanding that they enable will be inexorable.

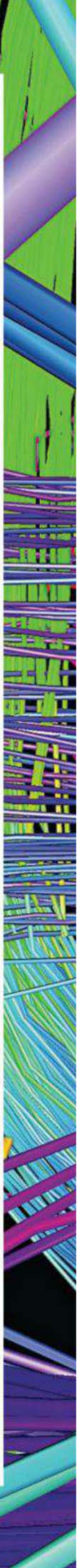
Connectomes will dominate thinking about what it means to be human. The transhumanism movement has developed elaborate schemes for transcending the human condition, but are the odds in their favour? Does the ambition of cryonics to freeze the dead and eventually resurrect them have any chance of success? And what about the ultimate fantasy of uploading, of living happily ever after as a computer simulation, unencumbered by a body or a brain? Using connectomics we should be able to test these claims empirically.

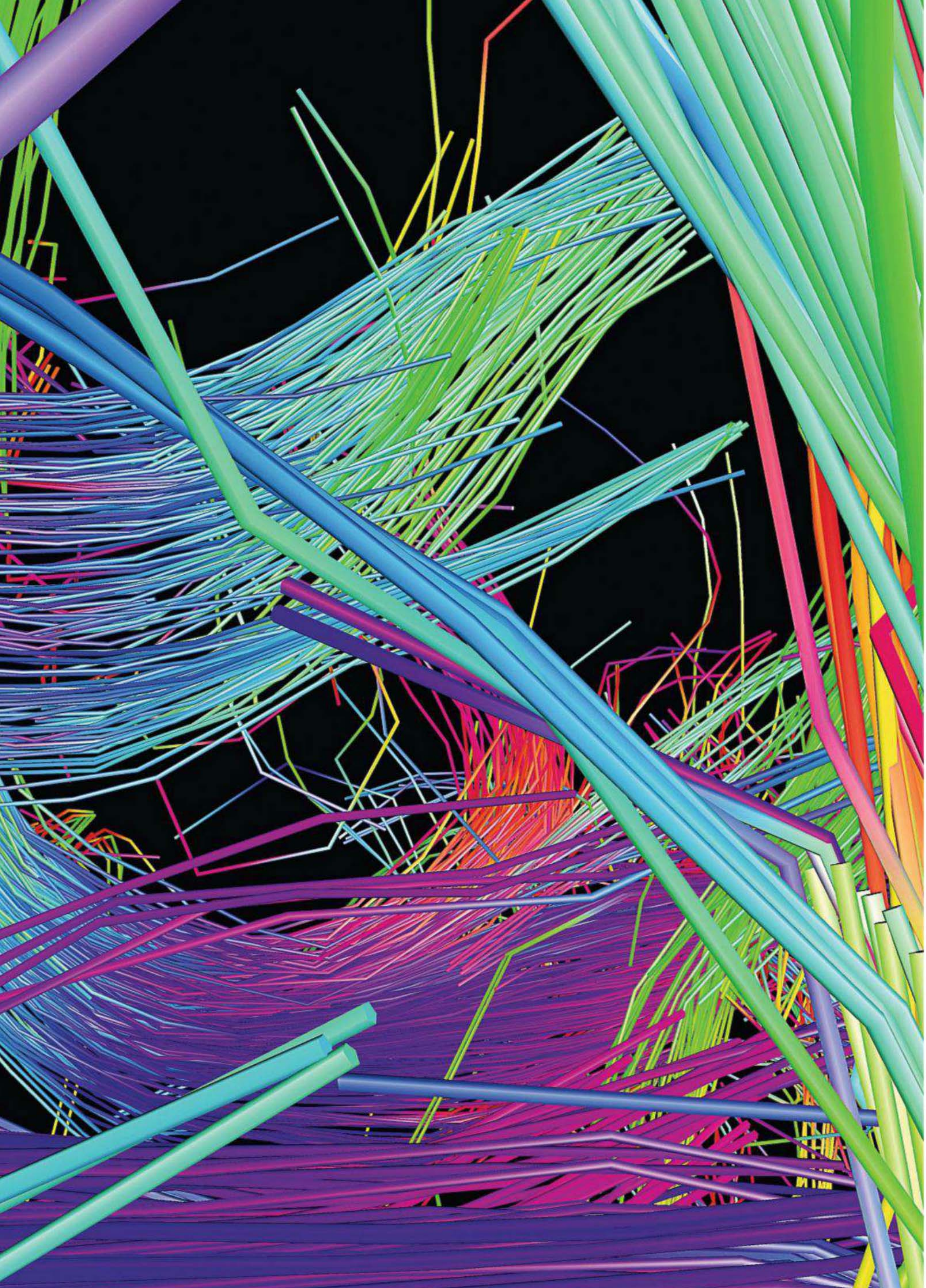
But before questions of the afterlife are investigated, fundamental questions about this life must be addressed. In particular: why are people different? Connectomics may offer us an answer to this, and other, mysteries of the human condition. W

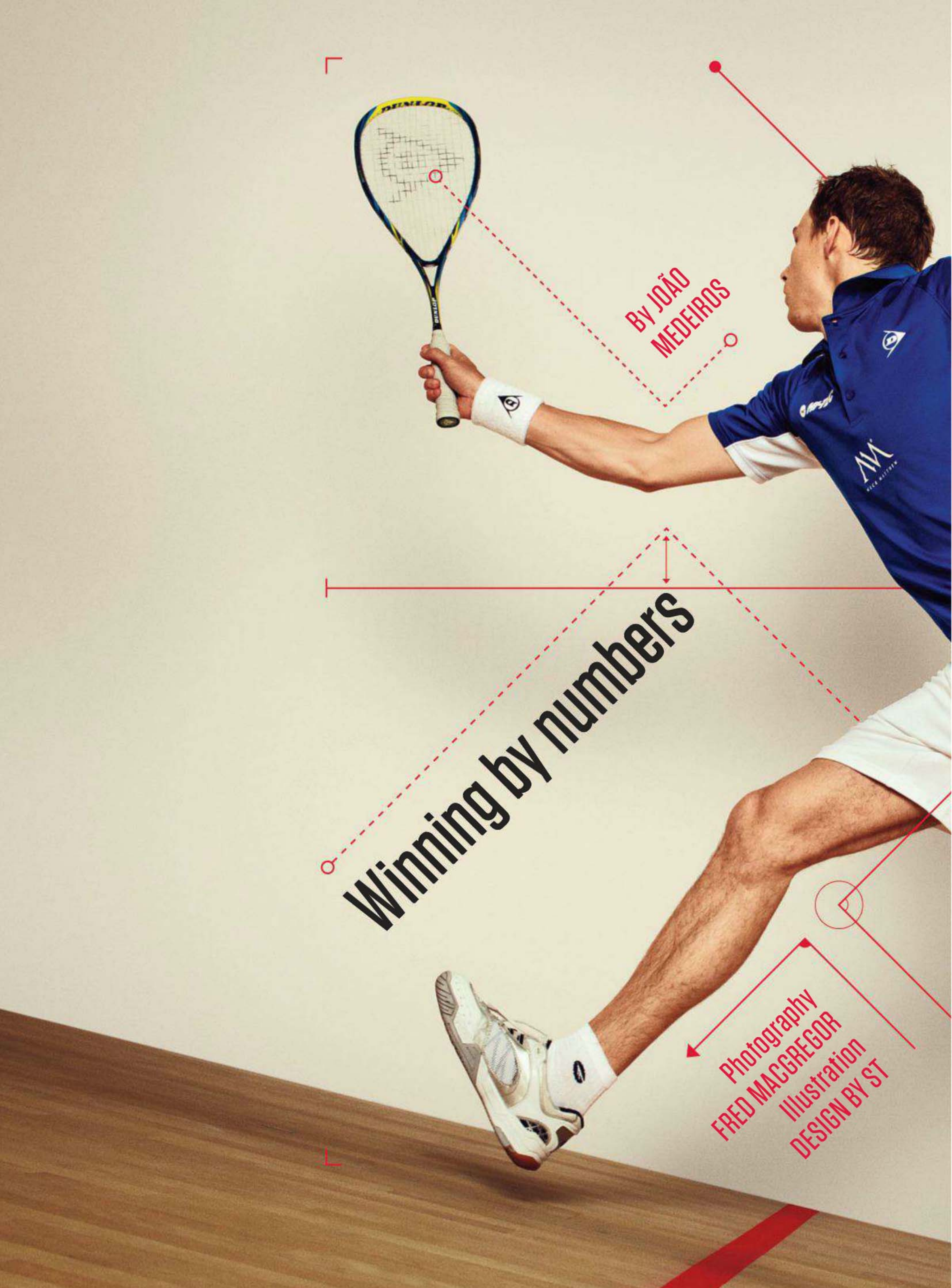
BELOW: A ROUNDWORM'S NERVOUS-SYSTEM MAP. *RIGHT*: FIBRE ARCHITECTURE IN A HUMAN BRAIN. BLUE FIBRES GO THROUGH THE BRAIN STEM; RED GO LEFT-TO-RIGHT; AND GREEN GO FRONT-TO-BACK



Extracted from Connectome: How the Brain's Wiring Makes Us Who We Are *by Sebastian Seung, published by Allen Lane on June 7 at £20. Copyright Sebastian Seung 2012. penguin.co.uk. Imagery from humanconnectomeproject.org*







Winning by numbers

By JOÃO MEDEIROS

Photography FRED MACGREGOR
Illustration DESIGN BY ST

Performance analysis and the science of skill acquisition are transforming competitive sports

Soon after becoming a professional squash player at age 18, Nick Matthew left his coach. He brought in David Pearson, then England's national squash coach, and performance analyst Stafford Murray. Matthew had been playing since the age of eight and had consistently ranked among the top junior players in the UK. He was a strong athlete – he had been a cross-country runner for many years – and typically won by wearing down his opponents. But as a senior player his physicality was no longer an advantage against much stronger opponents. He realised that he wasn't good enough.

"His technique was not the best," says Murray. "He was very strong, and mentally one of the best. But you talk about naturally gifted players and he certainly wasn't one." Murray is the head of performance analysis and biomechanics at the English Institute of Sport (EIS) in Manchester, overseeing 25 staff who work across all national sports teams. In his mid-thirties, he has the no-nonsense manner of a sports coach and the academic enthusiasm of a scholar. Murray was mentored by Mike Hughes, who pioneered performance analysis in the early 80s, using PCs to record and process data in real time during squash matches. "I tell my students – Stafford is the best performance analyst in the country," says Hughes.

When Murray began working with Matthew, they would meet four times a week. Murray would bring cameras to the court and analyse Matthew's technique using Dartfish, a video-based software program. Murray saw that Matthew was mostly using his wrist, rather than his whole body, when taking a backhand shot; as a result, he couldn't generate much power. Using Dartfish, Murray would break down the movement in strobe motion. He would also compare it with how Matthew was performing that same move previously by overlaying a ghost image on the screen. Matthew would hit a dozen balls and then look at the monitor. His coach would feed him the ball slowly, as if he were a beginner. He would spend hours on court each day, just practising his backhand, over and over.

"I had been playing since I was a kid and now I was learning how to hit a ball from scratch," Matthew says. "I felt a lot of self-doubt. I kept thinking, 'Do I really need to go through this? I'm already a good player.' It was the hardest thing I've ever had to do." When he began training with Murray in 2001, Matthew had been playing squash for 12 years and was ranked among the top 100 players in the world. It took him two years to relearn how to hit a ball but, by 2004, he had climbed to the top ten. Six years later, he became the world's number one player.

In December 2010, Matthew played against his compatriot James Willstrop in the final of the Saudi PSA World Open Squash Championship. Matthew had already beaten the four-time world champion Amr Shabana in the semifinals, and won the final against Willstrop by three sets to one, winning the last two games 11-2 and 11-3. "Destroying someone with my squash game as opposed to tiring him out was unique for me," says Matthew. "That's when it all came together."

In elite sports, being the most talented is no longer enough; top athletes also have to ensure they are the better prepared. They understand that their only sustainable advantage is to learn and improve faster than their opponents. The technology used by performance analysts allows them to measure every force, dissect every movement and time every action with absolute precision. That feedback allows athletes to find areas for improvement and aids the learning of new skills.

In the general domain of skill expertise, objective feedback rarely follows action. Experimental physicists have to wait for years to obtain validation of their theories; doctors seldom get immediate confirmation that their diagnoses are accurate. Elite athletes, on the other hand, can get immediate and precise feedback for every movement that they make, right down to the tiniest manoeuvre. They have become used to using scientific knowledge and data feedback to optimise the way they train, making it more efficient and effective. Coaches call this "accelerated learning". Elite athletes haven't merely mastered their sport. They have mastered the art and science of learning.

At the EIS, Murray's team of performance analysts and biomechanists are working with Olympic athletes as they prepare for the London 2012 Olympic Games. From tae kwon do to sailing, from

Performance analyst Stafford Murray at Sportcity in Manchester

cycling to boxing, Murray's team of performance analysts collects data and analyses it. "The fundamental methods are generic. The guys working with the sailing team will have a look at what the tae kwon do analysts are doing and the guys in boxing will come down to study the methods of the squash analysts," Murray says.

At the Manchester Velodrome, BAE Systems has developed a timing system based on military technology that uses lasers and bar codes on athletes to give exact identification, split times and velocity data. Bikes have instrumented cranks that capture force measurements, velocity and acceleration. The data is logged in real time via a system developed by McLaren and performance analysts stream the video of the cyclists' workouts directly to the coaches' iPads. It has paid off: the British cycling team brought home 14 medals at the 2008 Beijing Olympics. Performance analysts also make extensive use of Dartfish, created at the Swiss Federal Institute of Technology in Lausanne, which allows them to record performance, annotate video clips, overlay extra footage and add time codes.

Murray likes to cite a particular statistic: coaches can recall only about 30 per cent of what they see during a competition. In other words: 70 per cent of potentially vital information goes unnoticed. That's where his expertise as a performance analyst lies – in finding objective data that will make his athletes accelerate their learning and outperform the competition. "I worked with a squash player who wasn't hitting the ball at the right point during the swing," Murray says. In squash, he explains, players should take the ball on the top of the bounce when it comes off the floor. If you take it on top of that trajectory, you're not giving your opponent any time to get their breath back. "This player was hitting it just off the top of bounce," he says. "I calculated his timing and estimated that he was losing about two minutes throughout the match. He was basically giving his opponents two extra minutes. This is the sort of data that we have to find. If we're not changing their behaviour and accelerating the way they learn new skills, we're failing."

In their 1967 book, *Human Performance*, American psychologists Paul Fitts and Michael Posner put forward a model which posited that people go through three distinct stages when learning a new skill. They called the first stage the cognitive stage. This is where we intellectualise the task at hand and search for strategies to accomplish it. The conscious part of the brain is fully engaged. Take learning a language as an example: at the cognitive stage, you are trying to understand the basic rules of grammar, you are learning the first words and are attempting to pronounce the different phonetic sounds correctly.

After some experience, learners reach the second stage of learning, which the authors called the associative stage. At this point, the learner has developed knowledge of what, how and when to do something. He or she starts to practise and receive feedback. The conscious mind is no longer grappling with the unknown, but being competent still requires full conscious concentration. As the learner practises, the new skill slowly migrates to the unconscious level.

At the third stage, the autonomous stage, the learner stops being a learner. The skill becomes second nature and can be performed almost unconsciously. Psychologists say that the learner has reached a level of unconscious competence. Speakers reach this level of competence with their native language, whereas adult learners of a second language typically struggle to reach the autonomous stage, even when fully immersed in the foreign culture. Reaching autonomous competence isn't easy.

In sport, elite athletes possess more than mere unconscious competence: they have unconscious mastery. This level of skill often produces what is known as a "flow experience", a mental state at the extreme of the unconscious competence spectrum that typically results in unbeatable performances. In 1988, at the qualifying stage for the Monaco Grand Prix, the late Brazilian

Formula 1 driver Ayrton Senna described a record-breaking lap thus: "I was already on pole, then by half a second and then one second and I just kept going. Suddenly I was nearly two seconds faster than anybody else, including my teammate with the same car. And suddenly I realised that I was no longer driving the car consciously. I was driving it by a kind of instinct, only I was in a different dimension. It was like I was in a tunnel. Not only the tunnel under the hotel, but the whole circuit was a tunnel. I was just going and going, more and more and more and more. I was way over the limit, but still able to find even more."

When we think of the prowess of Olympic athletes, of course, we tend to consider its physical manifestation. For instance, Cristiano Ronaldo, who is considered one of the best football players of the last decade, is what we might call the complete physical athlete. He has the long legs of a sprinter, the lean physique of a middle-distance runner. He can jump about 80cm in the air, higher than the average professional basketball player. Added to his physical attributes, what makes Ronaldo a great player is his supreme co-ordination and masterly skill with a football.

But how is the physical ability of athletes related to neurological capacity? One example is anticipation. Mark Williams, a professor of motor behaviour at Liverpool John Moores University, has looked at how elite tennis players, for example, react to the movements of their opponents. He placed tennis players in front of a large screen on which he projected a life-sized opponent performing a serve. He had them anticipate their opponent's action by responding physically to the film. He then occluded parts of the clip sequence – for instance, making the screen go black just before the ball was struck – to find out whether the tennis players could anticipate the opponent's serve.

"What you find in fast-paced sports, such as tennis, is that the time taken for the ball to travel from one opponent to the other is often shorter than the combined sum of the athlete's reaction time and movement time," Williams says. Athletes need to initiate a response before an opponent actually strikes the ball. Typically, they have already anticipated where the ball is going 120 milliseconds before the ball made contact with the racquet.

By using an eye-movement sensor, Williams found that the players don't even look at the ball, but predominantly at the trunk, hips, shoulders and the arms of their opponent. Unconsciously, they extract this visual information to anticipate accurately what's going to happen.

Another cognitive skill used by elite athletes in team sports is the ability to recognise patterns during a match. Williams devised a study in which footballers of varied proficiency were shown a film simulation of an attack. "Say you have a centre-half on the edge of the penalty area and the ball is on the halfway line. What we find is that this player will be using lots of fixations of short duration, scanning, picking up position and movements of players," Williams said. "He's analysing the structure of the game. Subconsciously, he's doing maths. He's calculating event probabilities for each given situation at every single moment, based on his experience of the game. It's as though he has a database in his head, with a probability assigned for every play pattern that he might encounter in the game."

The factor that sets elite athletes apart, then, is not just what they can do but knowing precisely when to do it. In a La Liga game against Rayo Vallecano last February, Real Madrid's Ronaldo chased a ball that had bounced off a defender on a straight line and, with his back to the goal – which was ten metres away – backheeled the ball past four defenders and the goalkeeper and into the net.

"He didn't even need to check where the goal was," says Zoe Wilmhurst, a visual-skills sports expert who works with Olympic athletes. "Ronaldo's spatial awareness is off the charts. Players like him are like scholars. They simply tap their memory banks, with their thousands of different permutations of the game, and based on the data they retrieve, they are able to make decisions with very little information and without even thinking."

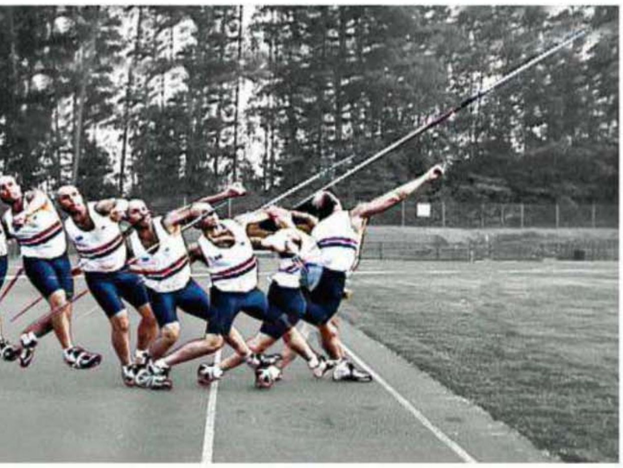
Even after he'd started working with Stafford Murray, Nick Matthew would go into tournaments thinking about his technique. "Mentally, it was a lot of baggage to take into the game," Matthew says. "You get analysis paralysis. I would feel really happy with my progress during a session and then go into a game, and as soon as I was put under a bit of pressure, my technique would just fall to pieces."

This is not unconscious competence. Matthew was still aware of how his body was moving, of when he was releasing his wrist.

THE SOFTWARE THAT WINS GOLD

Performance-analysis software Dartfish lets coaches and athletes time-capture, edit and tag video footage. One of its features, SimulCam, enables superimposition of two athletes in the same competition to make comparisons; and StroMotion (*see right*), is based on stroboscoping, a method of dissecting movement into a frame-by-frame sequence so that an athlete's movement is displayed as a series of static images. Usain Bolt's coaches used the software during the preparation for the 2009 World Athletics Championships in Berlin, when Bolt broke the 100-metre world record. In the 2010 Winter Olympics in Vancouver, 162 medal-winning athletes used the software. Dartfish has signed an exclusive partnership with the British Olympic Association for London 2012: performance analysts housed near the Olympic Village will get access to the Olympic broadcast feed, which will show every minute of every event. "In athletics, there's a big gap between what you think you did as an athlete and the coach's observation," says Victor Bergonzoli, CEO of Dartfish. "We bridge that gap."

Nick Matthew, using new techniques at Hallamshire Tennis and Squash Club



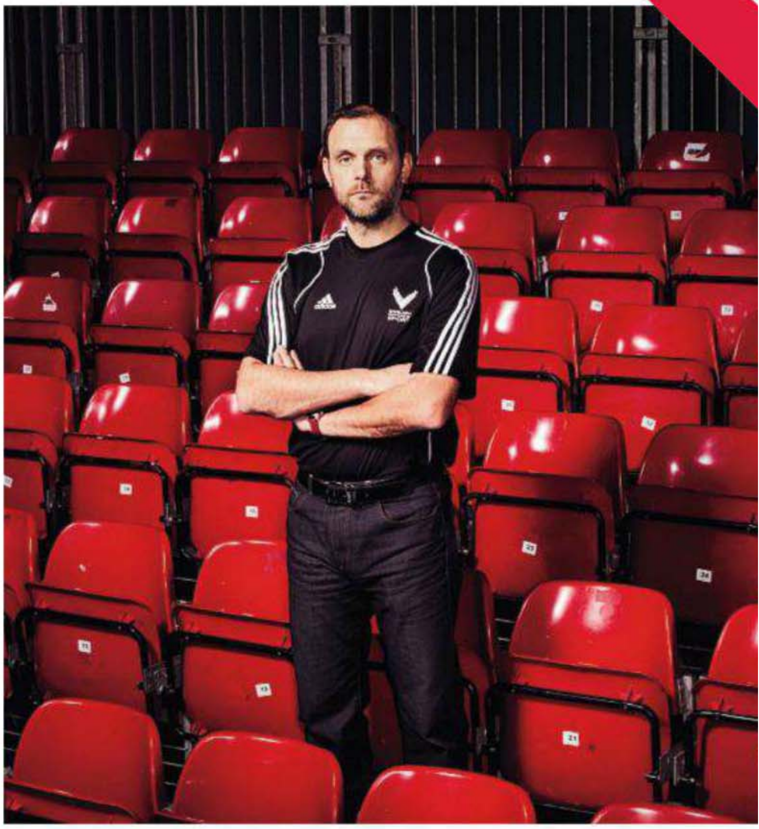
He was still at the cognitive stage. "People appreciate how hard you have to work physically, but they don't understand the attention that goes into detail from a scientific point of view," Matthew says. "The endless hours to change one per cent of the angle of your swing. That might make the difference between playing a drop shot into the nick and just missing it."

What Matthew is describing is not a failure of willpower or of talent. Rather, it is one of the key components of accelerated learning. Unconscious competence doesn't just happen. You reach it by forcing yourself to remain in the cognitive stage in training. This means that you have to practise the skills in which you are not yet competent, making your practice mentally effortful. To use the sports colloquialism, you have to "overload" your training.

One of the ways to do this is to do things with more intensity. Take Sarah Storey, a British Paralympian cyclist, who won two gold medals in Beijing. "When I practise on the road, I can fly at 80kph, get round the corners at more than 50kph, overtake cars," Storey says. "But when I started I was like, 'No way I'm overtaking a car'." She had to engage in what she calls "neurological training". Every time she went on the track at the Manchester Velodrome, she would force herself to cycle as fast as she could and she now often trains at velocities above world-record pace. It took her a year before she was overtaking cars frequently. "It's no use if you're going at 60kph round a 250-metre track and you get dizzy and your front wheel is wobbling because it's too fast to handle," she says. "Your nervous system has to be able to handle the bike at speed and to send messages to the brain so that the legs turn faster."

In more complex sports the challenge is not just to reinforce existing skills but to create different ones. In a study, University of Alberta sports scientists Janice Deakin and Jean Côté found that highly skilled figure skaters spent more time practising the moves that they couldn't do so well, trying different solutions, and failing (and falling) much more often, whereas the novices preferred easier practices. At the University of Liverpool, Mark Williams has found similar results. "The best athletes always practise at the edge of success and failure," he says. Williams compares it to a Darwinist process, because expertise arises from adaptations to constraints. "Athletes have to find solutions to problems they will encounter in competition," he says. "They fail, repeatedly, and it's by trying that they will eventually solve the problem and register the solution. The result is adaptation."

Nick Matthew describes an exercise that he uses to improve his positional awareness in the court: the traffic light system. "Stafford installs two cameras in the court," he says. "One behind the court and focused on the front wall, which is red at the top, amber in the middle and green at the bottom. A second overhead camera looks down on to the floor, where there are red areas in the corners, green around the middle – a big circle – and then amber in the other areas." Players who usually control the green areas win the match, so he spends whole sessions trying to play in green. "You change your whole movement to get that change – suddenly you use the full dimension of the court," he says.



Murray invited Williams to give a series of talks on the theory of skill acquisition to his team of performance analysts in October 2010. In late 2009 the British Olympic archery team recruited a new coach, an American called Lloyd Brown. When Brown later assessed his new team he noticed that some of the athletes were using an inefficient technique when drawing the bow. With three months left for competition, Brown was keen to apply Williams's theory to accelerate the learning of a better technique.

Sports scientists make an emphatic distinction between two types of feedback. Intrinsic feedback comes from the athlete itself and varies in degrees – say, the awareness of the archer that he or she has just missed the target – to a more attuned perception of movement, such as how much force he or she has produced in the bow. Extrinsic feedback on the other hand, originates from outside sources, from the coach shouting instructions on the sidelines to the post-match video analysis. In a sense, extrinsic feedback is what allows the athlete to compare how he or she has really performed with how he or she *thinks* they have performed.

"It's fundamental that athletes get feedback to learn, but what's the best method for coaches to provide feedback and promote accelerated learning?" Williams asks. Sports coaches usually assume that the best way to run a practice session is to provide lots of instructions and hands-on demonstrations. This, however, is not the best way to accelerate learning. "Athletes become dependent on that feedback," Williams says. "When it comes to the competition, they aren't able to replicate that skill. Athletes need to create self-sufficient mechanisms of feedback."

A study by Nicola Hodges and Ian Franks, professors at the University of British Columbia school of Kinesiology, for instance, showed that novice football players would learn faster

How to accelerate your learning

Overload your training and push yourself

If you want to get bigger muscles, you overload your training with heavier weights. To some degree, the brain is like a muscle. You can overload the brain by increasing the intensity of your training (by doing things faster, for instance) or by practising skills you're not so good at rather then the skills you've already mastered.

Get objective and precise feedback

Without feedback, there's no change in performance. External feedback from personal observation is usually biased. The more objective the feedback, the greater effect it has. As athletes improve, they need less, but more detailed, feedback. They also become better at evaluating their own performance.

Mimic the pressure of competition

To gain the greatest benefits in terms of improved performance, practice sessions should match the demands of competition. Try to re-create the randomness, variability and emotional pressure of contest. The closest to the real thing you can get, the more effective the preparation.

by following general verbal instructions, such as "Can you pass the ball into the near-post area?" rather than being taught specifically how this could be achieved. Coaches, then, need to be able to provide the least amount of extrinsic feedback required to progress and let the athletes engage in self-discovery, in trial and error. This fine balance between extrinsic and intrinsic feedback helps athletes calibrate their own perception of their performance, which accelerates their learning. Novices need more feedback. As athletes become more skilled and experienced, the feedback they require is more detailed and less frequent.

After the workshops with Mark Williams, Brown and EIS performance analyst Oliver Logan designed a programme to teach their archers to relearn how to draw the bow. They first asked the archers to try the new technique in the easiest possible way with an elastic band, rather than a bow. They would have cameras overhead and use live video feedback and practise while watching themselves from above. Later, they delayed the feedback by ten seconds, allowing the archers to cross-reference what they thought they did with the visual feedback from the video. Sometimes, unless the trial had been particularly bad, they wouldn't get any feedback at all. After a couple of months, the archers were already practising with targets, with background noise to mimic real crowds and in direct competition with other archers. Brown would call their name out and commentate live. They would also give the archers small financial incentives depending on their score, or force them to drink a pint of water so that they would shoot while needing urgently to urinate.

"It's important to make training as replicable to match play as possible," Stafford Murray says. In six months, the archers had learned not only how to draw the bow differently, they had improved their scores by an average of ten points. Through accelerated learning they had reached unconscious competence. Of that group, three archers are expected to represent Great Britain in London 2012.

"In squash practice, sometimes we project a match against the front wall and have the player play a virtual match, so it's much like shadow boxing," Murray says. Players would be playing against the world number one, ghosting the movements in the match – exactly the same kind of movements that they would be doing were they playing in the real match. Physically, they would cover the same distance. Their heart-rate would be almost the same. "Performance analysis shows you exactly where the demands for competition are," Murray says. "We overload the training based on that data. There's no guesswork. You can't argue with the data."

Murray at the National Squash Centre, where he worked with Matthew

We commonly assume that athletic skill is a random combination of innate talent and mere accumulation of years of experience. Why? Because this analysis simplifies our understanding of skill. It allows us to think of skill of something more akin to a mystery than as an art or science that can be dissected and understood.

But that mindset wouldn't have helped the British archers or elite athletes like Nick Matthew. Instead, they methodically diagnosed and addressed their shortcomings using data and feedback. That's what accelerated learning is: a smarter approach to learning a skill. It provides a scientific way to look into skill, decompose it into its elementary components and address them.

Insofar as there are general principles that underpin expertise, it is potentially possible to take accelerated learning out of the sports arena and apply it to our skills in order to become better at whatever it is we do. With enough motivation, we can adopt the principles of accelerated learning and do what the great athletes do: shelve our perfect skills and employ a scientific approach to correct our imperfections.

TAKING THE FAST TRACK TO VICTORY

Amy Oliver, shown in October 2011, competing in the ladies' elimination round for London 2012, at Lords Cricket Ground. The venue has been adapted to host the archery events at the Games. Oliver first picked up a bow aged seven.

Nick Matthew competes against fellow English player James Willstrop in the final of the singles squash competition at the 2010 Commonwealth Games. The match was held at the Siri Fort Sports Complex in New Delhi.

Rebecca Romero wins gold in the individual pursuit event at the Beijing Olympics, in August 2008. Having won silver in rowing in 2004, Romero was the second woman to win Olympic medals in two sports; the first was Roswitha Krause of East Germany.

In Beijing in 2008, Great Britain finished fourth, with 47 medals, their second-highest haul in Olympic history. One of the 19 golds was won by Rebecca Romero, who had recently switched sports from rowing to cycling. She had rowed since the age of 17 and had won silver at the Athens Olympics in 2004 in the quadruple sculls, and gold in the World Championships the following year. In January 2006, she retired after a back injury, and decided to try cycling. The British cycling team tested her on a bike in a lab to measure her power output. "They said I had one of their best results ever," Romero says. "It was insane. I didn't have the physiology or the bike skills. Very quickly I was being taught everything and I was going from a nothing to being a member of the team and aiming for an Olympic medal."

Romero and Dan Hunt, her coach, devised a training plan. They determined what would be world-class times and what power output and speed she needed to break those times. Every detail was part of the equation: size of the gear, drag, humidity and temperature of the velodrome, body shape, body position. Romero would take notes of all her training sessions, recording what she done, her thoughts and where there was room from improvement. "I call it data ammunition," she says. "When I was preparing, we tailored all the training so that everything I was doing would lead me to be at the right point in two-and-a-half years. We couldn't afford unnecessary training."

In 2008, she qualified for Beijing – and won gold in the individual pursuit category final. Romero had been training for less than two years. "People talk about the ten years it takes to achieve something, but I believe you can accelerate the learning process if you are smart about the way you practise," says Romero. "It isn't just about the hours and hours of training, it's all the tiny things that add up."

João Medeiros wrote about medical microchips in 11.11

PHOTOGRAPHY: LEO MASON/CORBIS; PA; TIM DE WAELE/CORBIS

MARKUS 'NOTCH' PERSSON'S *MINECRAFT* IS A BLOCKY VIDEO GAME WITH NO RULES – BUT IT HAS HUMBLED A £40-BILLION INDUSTRY

BY **TOM CHESHIRE**

CHANGING THE GAME

PHOTOGRAPHY: **ALEXANDER BABIC**

Markus "Notch" Persson, with trademark fedora, in Mojang's office in Stockholm, February 2012

Markus "Notch" Persson is bopping his bald head to "Sexy and I Know It", one hand holding a glass of Dom Perignon, the other in the air. The Café Opera, a nightclub in Stockholm, is heaving; dry ice blasts the audience while Redfoo, one half of electropop outfit LMFAO, mixes bass-heavy songs on stage. Persson's booth is in the middle of the crowd; Jakob Porser, a cofounder with Persson of games studio Mojang, ignores the rest of the 1997 magnum and mixes Grey Goose vodka with Red Bull. He hands one to Persson, who points to the 1.5-litre bottle and says, "We're going to finish this." Carl Manneh, the third cofounder, huddles with Persson and Porser in the booth. The three board members of Mojang chink glasses.

It's the small hours of a Monday in February. Mojang is celebrating two milestones. The first is raising £280,000 for three charities, by making a new game from scratch in 60 hours. The second is selling five million copies of *Minecraft*, a blocky-looking game created by Persson three years ago. Originally a download-only game for PC, *Minecraft* has earned 33-year-old Persson £45 million and turned him into a celebrity in web and gaming culture. He's known to millions as "Notch" (the top definition of Notch on Urban Dictionary: "Another word for Jesus"). As Persson was shown into the Café Opera, several clubbers recognised him. They asked to shake his hand. Being worshipped, Persson says, "is a bit weird. I guess people feel like they kind of know me. The game developer me, or the Twitter persona, that's Notch. It's a censored version. The real me is Markus."

One weekend in summer 2009, before he became Notch and started wearing a fedora, Persson made *Minecraft*. It isn't like other games. There are no instructions, no levels, no mission structure, no story, no lives, no points, no clear goal. You start *Minecraft* in the middle of a randomly generated, blocky-looking world about eight times the size of Earth and are completely free to do what you want. You can go exploring or you can get creative. Every block in the world, whether it represents a tree, gravel or rock, can be harvested and subsequently "crafted" into a product – swords, pickaxes, torches. The two mouse buttons give the game its mechanic: one breaks blocks, the other places them. Your only aim is to survive. As night falls, this gets harder: zombies, spiders and other ne'er-do-wells emerge, meaning you have to find and build shelter.

Minecraft doesn't get more complicated than that, which is its appeal: a virtual version of Lego, it offers infinite creativity and control. Where other world-building games such as *Sim City* allow players to place prebuilt structures, *Minecraft* lets you make anything you want, from huts to cathedrals. The randomly generated worlds stretch forever and can be beautiful: archipelagos or rainforests stretching kilometres high; cave systems with flowing water and lava, and rare metals which offer the possibility of entirely new creations. *Minecraft* has no beginning and no end.

Players build gigantic digital monuments: the Taj Mahal, the USS *Enterprise* and a functioning calculator – all hucked out of the randomly generated dirt, stone and wood. There are 4.5 million YouTube search results about *Minecraft*, in which fans guide newbies or show off their virtual creations. Three million players log in every week; there are 240 million logins each month. Last November, 4,500 people from 23 countries paid between $99 and $139 (more than Persson has spent marketing the game) to attend Minecon, a conference dedicated to *Minecraft* at the Mandalay Bay Hotel in Las Vegas; the oldest delegate was 77 years old, the youngest four.

Peter Molyneux, an influential game designer, calls *Minecraft* "the best game of the last ten years. [Persson] didn't stick to the old rules of game design that most developers slavishly obey. The gift was giving people a world to play with. *Minecraft* trusts in people's ability to find their own entertainment in a digital experience, to choose whether they're going to build or destroy. It is a glimpse into a new world of digital entertainment." Persson has, according to Ian Livingstone, founder of Games Workshop and an adviser to the UK government on video games, "singlehandedly changed the world of videogames". Working by himself, a stocky, bearded developer from the middle of Sweden created a hit to compete with titles from multibillion-dollar companies such as Electronic Arts and Zynga. Persson did it by assuming

AFTER SALES OF MINECRAFT HAD PASSED 200,000 PAYPAL FROZE MARKUS PERSSON'S ACCOUNT, SUSPECTING HIM OF FRAUD

gamers wanted more than another shooter or farming title. As youareminecraft.com says, "the game has revealed how much creativity lies undiscovered within us". Persson unleashed it and changed the rules of a £40bn industry.

Just over 60 hours before the visit to Café Opera, the 18 employees of Mojang were preparing for a game jam – a well-practised format in which developers create a new game in a short period of time. Inside the Mojang offices in Stockholm, developers sits at desks strewn with hardware, *Minecraft* merchandise and Nerf guns. Two minutes into Mojam and 100 people have bought the yet-to-be-finished – or even planned – game. "That means we have to make it now," says Persson. After an hour, 993 donors have given $6,000 (£3,700). Pizzas are ordered and eaten, and then Mojang gets to work. Persson, dressed in a green Lacoste shirt and wearing his fedora, holds a design meeting in a small room with a whiteboard.

Thanks to a public vote, Mojang's latest game will be a real-time strategy shoot-em-up set in a steampunk ancient Egypt. "The combination of themes we got was a bit weird," says Persson, "but I think we'll pull something off." The team talk for half an hour, throwing out concepts ("we've got to have mechanised scarab beetles!"). Persson stands at the back of the room, guiding the discussion. "Let's just get started," he eventually says. Mojang will have to write the game code, network and rendering from scratch. Every developer returns to his desk. Persson sits at his in the corner, pulls on his green headphones and starts coding.

When he started *Minecraft*, in summer 2009, he was on his own. Over the course of a weekend in May, he wrote a basic game, which mashed up others such as *Dwarf Fortress* and *Infiniminer* into something entirely its own, and mentioned it on the TIGSource forum – a site for independent games players and creators. A month later, he charged people €10 (£8) to download the game. *Minecraft* sold 40 copies that first weekend. People started talking about it: they had to, because there were no instructions. You could figure out how to make a bed, say, by trial and error – three slabs of wood, three bundles of wool – but it was easier to ask others. Persson also released *Minecraft* as an alpha – the core gameplay was established, but the game was, deliberately, left incomplete. Every Friday, Persson would update it, adding features. Every time, sales rose. "The main reason, I think, is because people talk about the game," says Persson. He had always been an active member of the TIGSource discussions and now he engaged with Minecraft's early players, on the forums, on Twitter (Notch has 660,000 followers) and on his Tumblr page.

As players created their own worlds, Persson was expanding the universe in dialogue with those players. *Minecraft* became the talk of 4chan and Reddit. When sales hit 15,000, Persson knew he was on to something bigger than an indie release. In summer 2010, Persson set up Mojang, along with Porser, with whom he had worked at Flash-games developer King.com, and Manneh, his former CEO at jAlbum, a photosharing site. By now, sales had reached 200,000 and PayPal, suspecting fraud, froze Persson's account. Mojang would license *Minecraft*'s IP from Notch Development, meaning most money would go to Persson. A beta version of the game came out in November 2010. On January 12, 2011, Minecraft passed a million units sold. By April, it was at two million units. August, three million. Notch announced Minecon. A few days before the November event, *Minecraft* sold its four millionth copy. The game, constantly updated, still had not been released. It came out of beta, priced at €19.95, on November 18; the official release has sold 1.5 million copies. The independent developer had gatecrashed the big video-games publishers' party. And he was having more fun than they were.

MINECRAFT'S GREATEST CREATIONS

Minecraft players construct digital structures on a monumental scale and then post videos of them to YouTube. Among the most impressive are: a full-scale replica of Disney World's Magic Kingdom, built by 25 _Minecraft_ architects in four months; and a working graphic calculator, constructed from blocks, which covers about five million cubic metres in the _Minecraft_ world. The videos have racked up millions of views: if you build it, they will come.

1 City of Arches
2 Hogwarts
3 Magic Kingdom
4 Minas Tirith
5 Scientific calculator
6 USS _Enterprise_
7 Taj Mahal
8 _Titanic_
9 Temple of Notch

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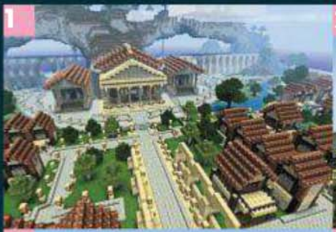

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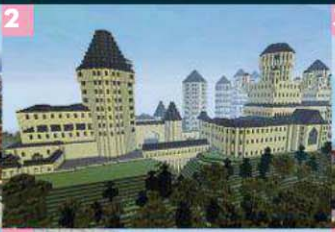

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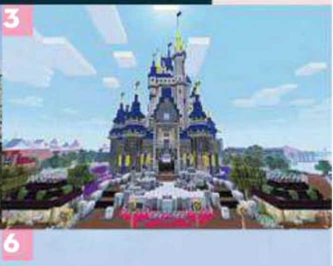

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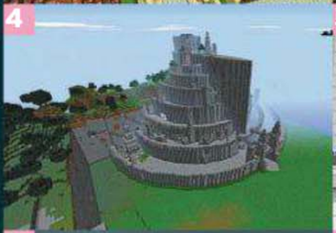

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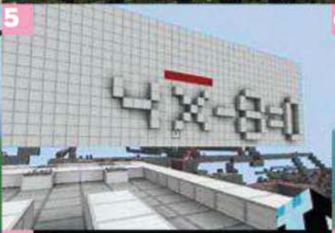

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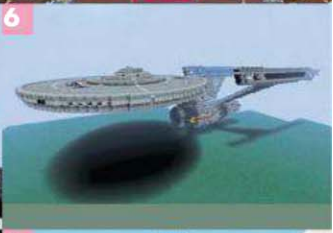

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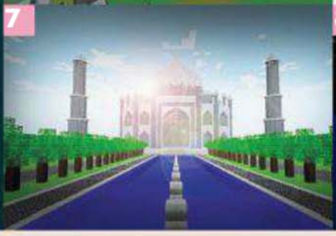

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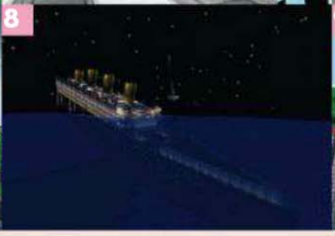

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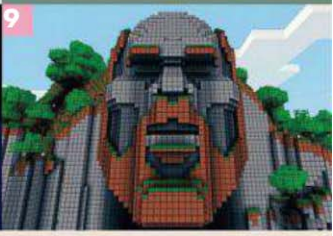


Sleeping...
Be back later!
Remote Controller
FART BOX

Left: Red Bull, Champagne and Nerf guns pictured during the 60-hour game jam, an attempt to create a game from scratch

Persson has a recurring dream. “Just wandering around the woods with my friends as a child, just barely not getting lost, which was kind of scary.” Markus Alexej Persson was born in June 1979 and grew up in Edsbyn, a small town in the dead centre of Sweden. “I was mainly outdoors,” he says, “exploring the woods.” His mother was a nurse and his father worked for the Swedish railway. “My dad was a really big nerd – he got a Commodore 128 and built his own modem.” At seven years old, his parents divorced (“It was pretty bad – I lost contact with my dad for several years”) and he moved to the suburbs of Stockholm with his mother. Persson started exploring the Commodore. “We had some tapes full of pirated games. The first game I bought was *Bard’s Tale*. I didn’t understand any of it. Too much English.” Persson never read the instructions.

At eight, Persson started programming, with the help of his sister. She would read out code listed in magazines. “That’s how I learned to program. I’m really a cowboy programmer.” The same year, he showed his father his first game, a text adventure; he couldn’t save the game itself, as he didn’t know how, so every time the computer was switched off, he’d retype it. Persson was well-liked at school, if not one of the popular kids. At 16, he transferred to a “gymnasium” – secondary education in Sweden – where he had one friend. He became a loner. “I started spending time at home, just programming, just games. I was obsessed with *Doom*. I wanted to replicate it.” Persson reverse engineered the entire engine, an achievement he rates behind only *Minecraft* itself. After school, he joined the IT boom in Stockholm, working as a web programmer. He left after a couple of years, figuring it would be easy to find another job; then the tech bubble burst. “So I was unemployed, doing remote-school stuff, for two years. Living at home with Mum.”

HAVING TURNED DOWN SEAN PARKER’S MONEY, THE MOJANGSTAS FLEW WITH PARKER IN HIS PRIVATE JET TO A PARTY IN A SOHO CLUB

He found work as a programmer and created, with a coworker, a sandbox game called *Wurm Online*; as in *Minecraft*, players created worlds, terraforming the land and mining underground. Persson then joined Midas, which would later be renamed King.com. The company produces a huge number of Flash games. Persson would make a new game every two months, and says he made 25-30 in total. He also met Porser. Alex Norstrom, now vice-president of growth at Spotify, used to work at King.com. “What separated Markus from other developers at King was he had a deep knowledge about games,” he says. “The King way of making games is to spec it out. Markus had a little bit of everything in him – he’s more like a one-man show.” Persson quit King.com after being banned from making games in his spare time. He spent the next month making *Minecraft*.

As *Minecraft* became more and more popular, Mojang was courted by investors; the three “Mojangstas” started living the high life. “During the spring of 2011, I had VC conversations every single day for three months,” says Manneh. “I probably talked to 100-150 VCs.” One of those investors was Sean Parker, the cofounder of Napster and first president of Facebook. He flew into Stockholm to meet Mojang, who made it clear that they were in no way looking for funding, as they had told every other investor. Still, they talked with Parker for a couple of hours about the potential of *Minecraft* and the video-games industry in general (“He was a super fun guy, I have to say, but I don’t think his heart was in the games-development business,” says Porser). Parker mentioned he had his private jet at the airport. “And then he asked if we wanted to come to a party in London,” remembers Persson. “Yes!” The four flew to London to watch Cee Lo Green play a private party at The Box, a club in Soho. “We went and partied all night and came back the morning after,” Manneh remembers.

Mojang was able to turn down the investment because by the end of 2011 *Minecraft* had made about £52 million in revenue – not far off the £62 million Rovio took from *Angry Birds* in 2011 (WIRED 04.11). *Minecraft* merchandise – T-shirts, foam pickaxes, cardboard character heads – accounted for eight per cent of those revenues. With the licensing deals, Mojang itself made £4.5 million in profit up to the end of 2011; the rest went to Persson (for 2011, he said it was £33 million). “I keep these big piles of cash under my bed,” Persson deadpans. Thanks to Parker, Persson has acquired a taste for private jets himself, “because it’s so awesome. Not to buy them, that’s very expensive, but there are good ways to rent them.” He’s bought watches, too, from Baume & Mercier. Persson’s rule is that he saves half of his earnings, and spends the other half. “Which is a huge amount of money – there’s no way to spend that much money. But there’s no way I can go broke.” Persson is generous with his wealth; he gave his £2.2 million Mojang dividend for 2011 to his employees.

The other thing Persson likes is parties. As Vu Bui, a filmmaker and photographer who produces videos for Mojang, puts it: “Markus loves getting wasted.” Minecon’s closing party was at Encore, a club in Vegas. “I was way too drunk. I was partying and everything went pitch black. Then I opened my eyes and I was in my bed.”

Person didn’t dream of anything that night in Vegas, let alone exploring the woods. For all the private jets and parties, he still spends most of his free time playing video games, including *Minecraft*. “I do have a pretty huge ego

– yeah, well, more like pride over the game," he says. "But no, I'm not Jesus at all. I'm just a vocal guy who happened to have a big success." When Persson plays *Minecraft*, he doesn't build the extravagant structures you can see on YouTube. "I can't build anything close to what others do. Something about exploring is just very fun to me. I still get that thrill, when you find a cave."

A few weeks before Mojam, Double Fine, an indie developer in the US, announced a fund on Kickstarter, a crowd-funding site for creative projects, aiming to raise $300,000 over the course of a month for the development of a new adventure game. In 24 hours, they raised $1 million, becoming the then best-funded project in the history of Kickstarter. In 2010, several independent games developers set up The Indie Fund, a for-profit investment vehicle to encourage the creation of indie titles. It has backed six new titles so far and the two released have both been profitable; one of those, *Dear Esther*, an eerie and obtuse adventure game, made money 16 hours after release. Other recent titles such as *Journey*, *Fez* and *The Witness* have found that experimental, challenging gameplay can equal financial success. "We're in the middle of a renaissance for indie gaming," says Persson. And it's partly because of *Minecraft*. "Notch is the poster boy for the growing number of indie developers who are leading the disruption in a golden age of games," says Livingstone. "Mojang has torn up the rule book."

ROVIO, THE CREATOR OF *ANGRY BIRDS*, HAS SAID THAT IT WANTS TO BE A NEW DISNEY. PERSSON SAYS, "WE'RE MORE LIKE PIXAR"

Persson wants to spend his new wealth investing in games, but is wary of becoming a capo of indie gaming, dispensing favours and making developers just by attaching his name to them. "I don't want to be Don Corleone. We want to avoid a position where we decide what gets published," he says. But Mojang is making its first steps towards becoming a publisher; last year it put out *Cobalt*, an indie title from Oxeye Game Studio. "It's a great way of making more money, and building brand awareness for Mojang." It's the first step in moving beyond *Minecraft*; the company recently released *Scrolls*, the title Porser has been working on for the past two years, a card-swapping game. "We're trying to port *Minecraft* accounts to Mojang accounts," says Manneh. "We're developing more games, so that it will be easier for the user to make games." *Scrolls* will follow the *Minecraft* model of early release and continuous updates. "*Minecraft* has proved it to be a very successful business model," Manneh says.

Should Mojang be more ambitious? Rovio, the maker of *Angry Birds*, is, technically, an independent games developer; it's pushed that brand so hard that it's aiming for a billion-dollar IPO in Hong Kong later this year. Mojang doesn't want that scale. "I'd rather have us be part of an uprising of many companies in the rebellion against Zynga and EA," says Persson. Porser says, "All three of us, we're in it for the fun... We don't want to be a huge company." Manneh says that Mojang doesn't plan to expand beyond 25 employees or take investment. "We can take them on without the money. The way we develop games is very cost-effective." Independent gaming is as much about the spirit as the technicalities of ownership: like indie music, it is becoming a proper genre in itself. Rovio has said it wants to be a new Disney. Persson says, "We're more like Pixar."

"*Minecraft* will be our main revenue driver for quite some time," says Manneh. "And we want to focus on making the best of that opportunity." Mojang ported the title to mobile devices last year and has so far sold 1.4 million paid copies at £4.29 each. The company recently released an Xbox version too, which should help *Minecraft* reach a different demographic. "We look at the targets and projections we had last year, it's not even in the same ballpark," says the CEO. "We thought sales would be declining. But the rate is still climbing." Manneh estimates that profits for 2012 will be double those for 2011. This spring Mojang will launch *Minecraft Online*, providing a global network of servers for multiplayer. "If you really want to reach the mass market, it needs to be easier to set up," says Manneh. How many players do they think they'll reach? "Fifty to 100 million," replies

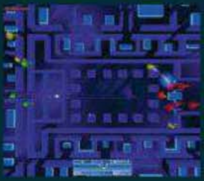
THREE MORE INDIE HITS MOST LIKELY TO BREAK OUT

FEZ

Montreal-based Phil Fish spent five years creating *Fez* – a colourful platformer that makes Escher-like optical illusions part of the gameplay – before releasing it in April on Xbox Live Arcade. The game won the grand prize at the Independent Games Festival awards in 2012 – *Minecraft* had won in 2011.

THE WITNESS

An upcoming 3D exploration-puzzle game for Windows and iOS from California-based developer Jonathan Blow, who developed the much-praised *Braid*. It's possibly too cerebral to go mainstream – Blow has been known to enjoy talking about the influence of the Italian novelist Italo Calvino on his work.



FROZEN SYNAPSE

A simultaneous turn-based strategy game for Windows and Mac created by Oxford-based Paul Taylor and Ian Hardingham. Since its release in May 2011, it has won *Minecraft*-like reviews from the gaming cognoscenti – but not *Minecraft*-like commercial success. Work is underway to port it to iOS devices.

Markus "Junk Boy" Toivonen, Mojang's art director, during the game jam

Manneh. "These are numbers just taken out of my butt, but if we look at 22 million registered users now, and the adoption rate, tying it in with Facebook Connect..." Mojang is creating an API, so that other developers can modify the game; Mojang will publish the best mods.

Persson himself is no longer directly involved with *Minecraft*; he handed over day-to-day development to Jens "Jeb_" Bergensten last year. Persson is working on a new game, *0x10c*, that takes the extreme freedom and innovative business model of *Minecraft*, and pushes both further. "It's quite ambitious," he says. Set in space, it's a sandbox title on an intergalactic scale; each player has a ship, which he or she can use to fight battles, mine, trade and loot, and explore planets. *0x10c* will be multiplayer, so Persson expects advanced economies to develop. The feature most exciting Notch fans, though, is the ship's computer – a working 16-bit CPU. "More programmatically advanced" players can create their own programs on this; Persson released the specs for the programming language as he himself started work on the game; within a week, several Reddit users had created their own emulators and one had even created a working version of *Minecraft* in the language. As in *Minecraft*, players can create anything – even malicious code that could corrupt the game itself – and swap and sell programs in the game. "I won't stop viruses," Persson wrote on Twitter in the early stages of development. "The players will do that." He is also experimenting with pricing: single-player mode will be a one-off payment, but multiplayer will require players to pay a monthly fee. As he did for *Minecraft*, Persson will release *0x10c* early and "let players help me shape the game as it grows".

Persson doesn't feel pressure with his new title, because even he thinks he can't create another *Minecraft*. "*Minecraft* is a massive phenomenon. It's not realistic for anything to come close." Persson is also designing, not programming, a "secret project" codenamed "Rex Quadro", for which Mojang has signed a deal with an outside company; Manneh says the deal could "make a big impact". Persson won't say any more: his mind is on the game jam. "I just want to go back to coding."

Sunday evening, February 2012. There are a few minutes left before time is up on the game jam. As Mojang hits several fundraising targets, in increments of $100,000, employees perform stunts to the camera streaming the whole 60 hours. Wine glasses full of Red Bull litter the desks, along with empty beer and vodka bottles. "This is actually starting to feel like a game now," says Persson, still typing with a machine-gun clatter on his keyboard. The deadline passes; Persson decides to "cheat by a few minutes" and a little later he finishes the last of thousands of lines of completely fresh code. "OK. The game is done." He claps and beams, beatifically. "Let's do this every weekend!" At closing time, the total raised is $436,097.08, from 77,234 buyers. The finished game, called *Catacomb Snatch*, isn't a masterpiece, but it's fun and playable; not bad for 60 hours. LMFAO's "Shots" starts playing loudly on the stereo. The Mojangstas wrap up and make their way to the Café Opera, singing along: "I'm fucked up... Shots shots shots shots shots..." Persson takes his fedora from the coat stand and leaves too.

Tom Cheshire edits the Play section. He wrote about flipped universities in 05.12

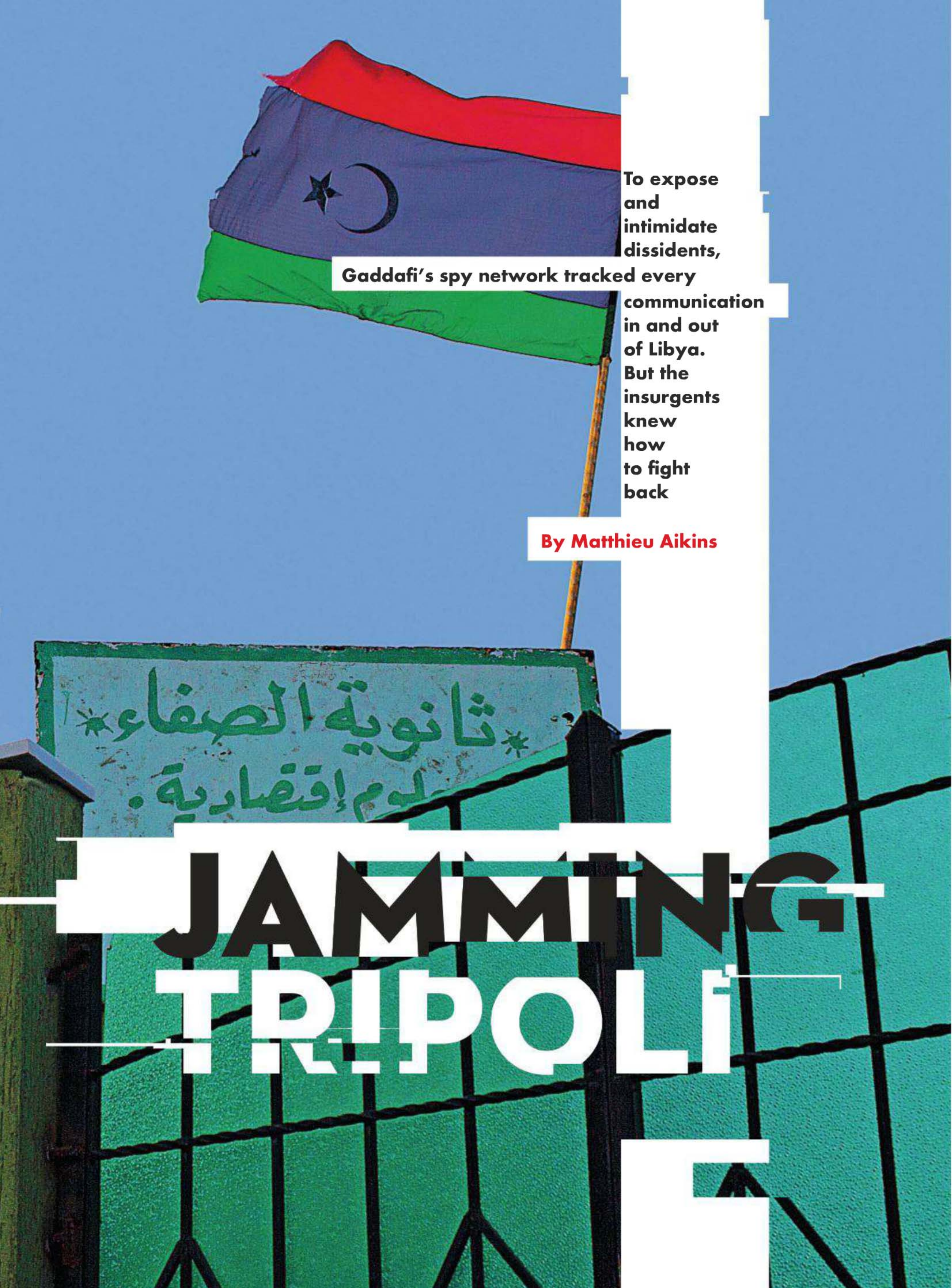
PHOTOGRAPHY:

MICHAEL CHRISTOPHER BROWN

JAMMING TRIPOLI

To expose and intimidate dissidents, Gaddafi's spy network tracked every communication in and out of Libya. But the insurgents knew how to fight back

By Matthieu Aikins



He once was known as al-Jamil – the Handsome One – for his chiselled features and dark curls. But four decades as dictator had considerably dimmed the looks of Muammar Gaddafi. At 68, he now wore a face lined with deep folds and his lips hung slack, crested with a sparse moustache. He stepped from the shadows of his presidential palace to greet Ghaida al-Tawati, whom he had summoned that evening by sending one of his hulking female bodyguards to fetch her. It was the first time Tawati had seen him without his sunglasses.

Libya was in an uproar. It was February 10, 2011, the beginning of the Arab Spring – a series of uprisings, revolutions and civil wars that would radically alter the politics of the Middle East. In Libya, opponents of the Gaddafi regime had called for a day of protest on February 17, to mark the anniversary of a 2006 protest in the city of Benghazi, where security forces had killed 11 demonstrators and wounded dozens more.

The internet enabled surveillance on a scale that would have been unimaginable with the old tools of phone taps and informants

Tawati was one of the most outspoken dissidents blogging openly from inside Libya. The 34-year-old had come to political consciousness during the mid-2000s. Her parents had divorced when she was young; in Libya, growing up with a single mother made her a social outcast. The injustice she experienced as a child led her to critique the injustice of the regime, particularly on women's issues, and over time she won a modest online following. As February 17 approached, she blogged that if Libyans failed to turn out for the demonstrations she would set fire to herself just as Mohammed Bouazizi had done two months earlier on the streets of Tunisia. Gaddafi himself had heard news of this threat and decided he needed to meet her.

Despite the dictator's haggard appearance, his manner remained confident and effusive. Gaddafi could be a legendary charmer, a man deeply at ease with ordinary Libyans. He seemed sympathetic to Tawati's request for more openness in Libya. Finally she worked up the courage to ask him why the government had blocked YouTube several months earlier.

Gaddafi acted oblivious. "Is it switched off?" he asked.

She complained to him about the way that allies of his regime had treated her. Ever since she'd started blogging under her own name in 2007, Tawati had been harassed – and worse. "Ghaida al-Tawati, the goat of the internet," read one Facebook page her attackers created; a string of graphic sexual comments was posted underneath her photo. More bewildering, though, was the invasion of privacy: somehow, emails of hers had been leaked on to the internet, even displayed on state television. She had been accused of working with foreign agents. Her reputation as a woman had been smeared, she told Gaddafi.

"If you want to get married," the dictator interjected, "we'll get you married to the best man."

"I'm not interested in getting married," she replied.

"So, have you made an appointment to burn yourself, then?" Gaddafi asked, a wry smile curling his lips.

Tawati said that she hadn't – yet.

"What do you really want from me?" he asked with exasperation.

"You already know the reason why people are demonstrating," she replied.

Then Gaddafi asked her to come and work for him. The two of them would solve these problems together, he said.

This was the moment, Tawati would later say, that she realised the uprising would succeed. The old man didn't understand just how committed she and other activists were to his downfall.

But like Tawati, these activists would suffer at the hands of Gaddafi's spy service, whose own capabilities had been heightened by 21st-century technology. By now, it's well known that the Arab Spring showed the promise of the internet as a crucible for democratic activism. But, in the shadows, a second narrative unfolded, one that demonstrated the internet's equal potential for government surveillance and repression on a scale unimaginable with the analogue techniques of phone taps and informants.

Ghaida al-Tawati had her email hacked and her Skype conversations recorded. Both were leaked to state television and broadcast to the nation

Today, with Gaddafi dead and a provisional government of former rebels in charge, we can begin to uncover the spying machine that helped the dictator cling to power.

The regime had been following Tawati online for years, and the harassment was mostly orchestrated by a group that came to be called the Electronic Army. According to former members, this loose organisation was founded several years ago when Mutassim Gaddafi, one of the dictator's playboy sons, had been enraged after videos of him attending a nude beach party on New Year's Eve were posted online. Mutassim, who chaired Libya's National Security Council, created a group of internet users, some paid, some voluntary, to try to take down those videos and other anti-Gaddafi material posted online. They bombarded YouTube with flags for copyright infringement and inappropriate content and waged a constant back-and-forth battle with critics of the regime, whom they would barrage with emails and offensive comments.

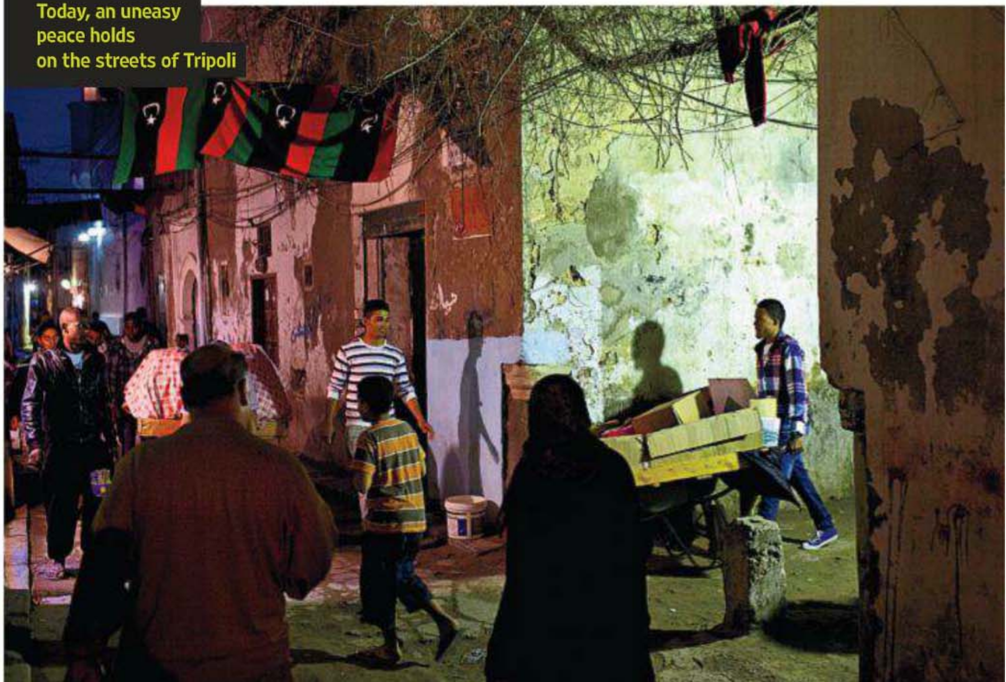
After all the cruelties she had endured as a child, Tawati could deal with the insults directed at her. But it stunned her when, in August 2010, some of her private email exchanges with other dissidents got leaked to Hala Misrati, a notorious TV propagandist and one of the Electronic Army's apparent leaders. How had her accounts been compromised? The answer, although she would not know it until after the regime fell, lay in a secret deal Gaddafi had made with a company called Amesys – a subsidiary of the French defence firm Bull SA – for technology that would allow his spy services to access all the data flowing through Libya's internet system. In a proposal to the regime dated November 11, 2006, Amesys (then called i2e Technologies) laid out the specifications for its comprehensive Homeland Security Program. It included encrypted communications systems, bugged mobile phones (with sample phones included), and, at the plan's heart, a proprietary system called Eagle for monitoring the country's internet traffic.

A related Amesys presentation explained the significance of Eagle to a government seeking to control activities inside its borders. Warning of an "increasing need of high-level intelligence in the constant struggle against criminals and terrorism", the document touted Eagle's ability to capture bulk internet traffic passing through conventional, satellite and mobile-phone networks, and then to store that data in a filterable and searchable database. The database, in turn, could be integrated with other sources of intelligence, such as phone recordings, allowing security personnel to pick through audio and data from a given person all at once, in real time or by historical time stamp. In other words, instead of choosing targets and monitoring them, officials could simply sweep up everything, sort it by time and target, and then browse through it later at their leisure.

In 2007, Philippe Vannier, former head of Amesys and current chief executive of Bull, reportedly met Abdullah Senussi, Libya's head of intelligence, in Tripoli. A deal was signed that year, and beginning in 2008 Amesys engineers and technicians, many of them former French military personnel, travelled to Libya to set up several data and monitoring centres for the country's Internal Security service. According to engineers at Libyan internet provider LTT, two high-bandwidth "mirrors" were installed – one on the country's main fibre-optic trunk and one inside the DSL switchboard – to copy all internet traffic and feed it into the Eagle system, which became operational in 2009.

One of the monitoring centres, known as HQ 2, was located on the ground floor of a six-storey Internal Security building on Sikka Street in Tripoli. Inside, a sign on an interior door bore the logos of both Amesys and the Libyan government and warned, "Help keep our classified business secret. Don't discuss classified information out of the HQ." Behind it, analysts sat at their terminals and used a web browser to log on to the Eagle system,

Today, an uneasy peace holds on the streets of Tripoli



Amesys, a French firm, sold the regime a "homeland security" program. It could capture and filter every bit of internet traffic passing through the country

where they would peruse their latest intercepts or search for new targets to monitor using keywords, phone numbers or email and IP addresses. The system was capable of collecting email, chat and voice-over-IP conversations, file transfers and even browsing histories from anyone who used broadband or dialup internet in Libya. The analysts could call up social-network diagrams for the targets they were hunting, with the links between each suspect showing the frequency and type of communication.

Emails of interest were labelled "follow-up" for the security services. A filing room with shelves of folders held thousands of printed-out emails and chat logs, case files with fingerprints and photographs and transcripts of phone intercepts faxed to the centre.

Eagle was only one of the tools the regime used against its online opponents. Unaware of the system's watchful gaze, Tawati assumed that her emails had started leaking because someone had gained access to her account. So in August 2010, she began chatting with a Libyan computer expert she had heard of called Ahmed Gwaider. She asked if she could hire him to help her, and he agreed. Unfortunately for her, Gwaider was a hacker in the employ of Libya's secret police.

The attitude of most Libyan hackers toward the Gaddafi regime tended to be hostile or at best neutral, but Gwaider got lured in. Rabia Ragoubi, a rebel sympathiser who befriended Gwaider when he joined a Linux users group that Ragoubi had founded, thinks the money proved too strong a pull.

Gwaider liked to trick his victims into giving up access themselves – a method called social engineering. He sent Tawati a Word document infected with a Trojan, which installed malware on her computer when she opened it. At that point he had access to everything, including her Facebook account and her supposedly encrypted Skype conversations, which Gwaider siphoned off with malware that recorded all the audio on her machine. All of it got posted to the internet in an effort to smear her.

Even expatriate dissidents, who lived out of reach of the Eagle system, were targets of Gaddafi's hackers. One such case concerned a Libyan who was studying at the University of Dundee in Scotland and blogging under the name Walid Sheikh. He was of particular concern to the regime because of his seemingly intimate knowledge of its inner circles. He often published details about embarrassing incidents that were not publicly known, such as the time Gaddafi's son Mutassim struck another senior official during a dispute at the National Security Council. In real life, Walid Sheikh was a 36-year-old dental student named Ali Hamouda. An unlikely dissident, Hamouda was the scion of an important family in the southwestern city of Sebha; in fact, Hamouda hailed from the same tribe as Abdullah Senussi and had even attended the wedding of the security chief's daughter. As such, Hamouda was well connected and seemingly had less to fear and more to gain from Gaddafi's regime than most Libyans. But studying overseas exposed him for the first time to the true history of the regime.

Hamouda began contributing to Libya al-Mostakbal, a website run by Hassan al-Amin, an exiled Libyan dissident living in London. He was cautious in his communications with Amin – the two never met in person, and Hamouda corresponded with him only under the name Nabeel. One day, while in Scotland, Hamouda answered a call on the special phone number he kept solely for his political activities.

"Hello, Nabeel, what's your student number?" a man asked him in Arabic. No one besides Hassan al-Amin should have known that name, let alone connected it to that phone number. He hung up and called Amin to tell him that one of their email accounts must have been hacked.

"Nabeel" had been compromised, but Hamouda felt confident that his true identity remained secure. In December 2010, after he had finished his degree and returned home to Sebha, he received a call from Senussi. This wasn't suspicious in itself; the intelligence chief had got Hamouda's phone number when the two met at his daughter's wedding.

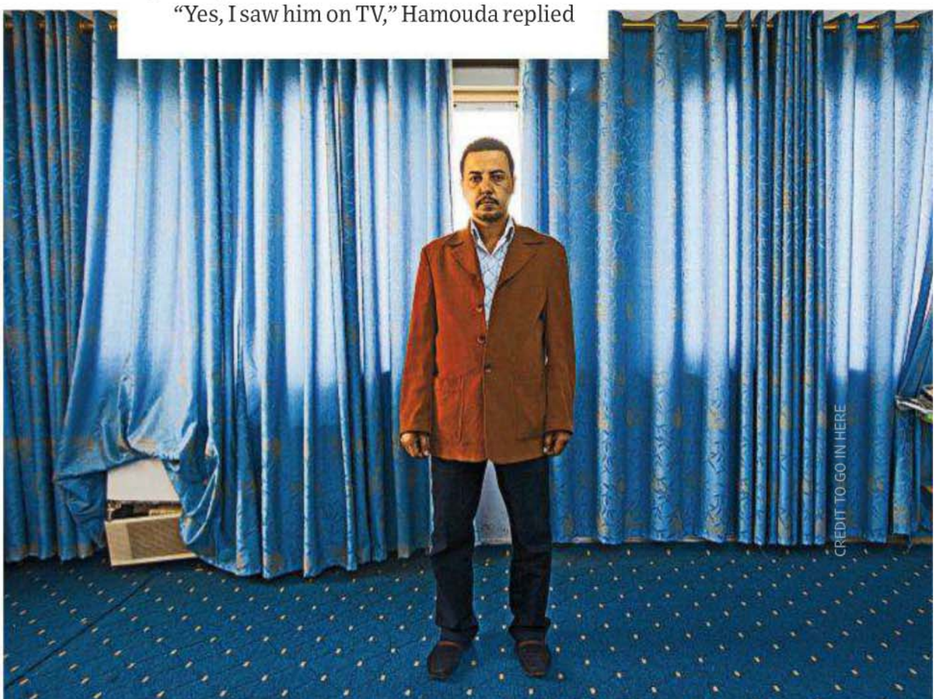
"Welcome back to Libya," Senussi said, before asking him to visit when he was in Tripoli. "You're so busy – tell me when I can have an appointment," Hamouda said. "How about tomorrow?" Senussi replied.

Arriving in the capital the following morning, Hamouda had breakfast in a café and then showed up at Central Intelligence, where he was ushered in to see Senussi. Hamouda was wary. The intelligence chief was infamous for the way in which his bland, friendly manner concealed a propensity for terrible violence.

Where exactly did he study? Senussi asked. Hamouda answered truthfully. What was his phone number and email address there? An aide came in with some papers.

"Do you know Hassan al-Amin, that dog?" Senussi asked, taking two files and placing them in front of him on the table.

"Yes, I saw him on TV," Hamouda replied



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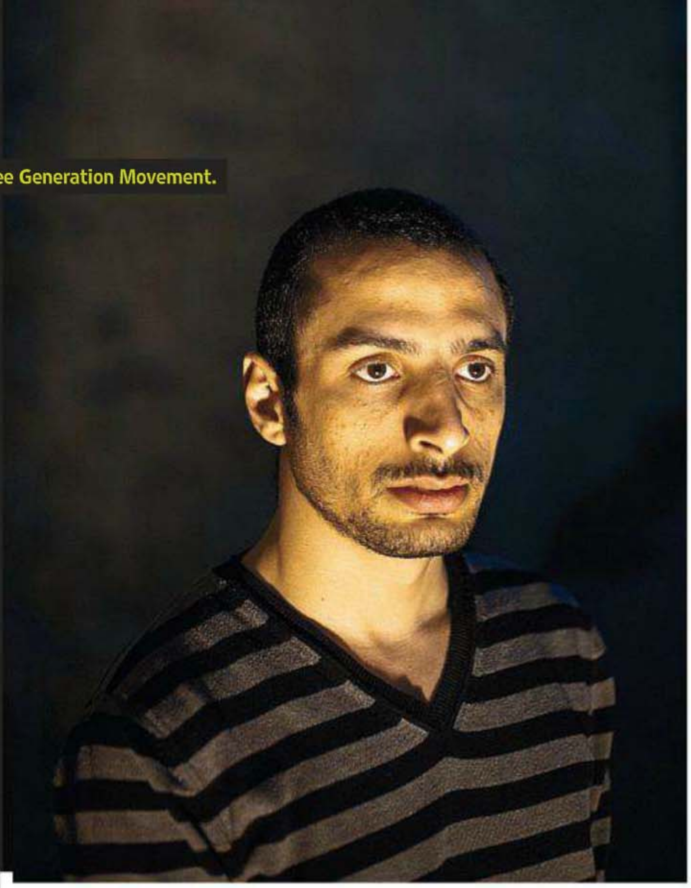

Mokhtar Mhani, one of the founders of the Free Generation Movement. During the war, when the regime had shut down the internet, Mokhtar and his cousin Niz hacked one of the few connections out

slowly. "Do you know him?" Senussi asked again, his tone sharpening. Hamouda broke eye contact and glanced down at the table. He noticed that each file had a different name. On one was his own. On the other was written "Walid Sheikh".

"I contacted him..." Hamouda began, but Senussi cut him off, shouting furiously: "You are an agent of foreign enemies! You are a betrayer!" Something snapped in Hamouda. He stood up, the blood rushingto his face, and began to shout back: "I never swore an oath to Muammar!" Hearing the commotion, two guards burst into the room and grabbed Hamouda, dragging him out to the hallway. He was thrown in prison for two months, where he was interrogated repeatedly about his activities online.

His identity had been discovered from the IP address on his emails to Amin. Spies had traced him to the dental school at the University of Dundee. Only four Libyan students were on scholarships there; only Ali Hamouda fit the profile of Walid Sheikh. Because of his family connections and the relative mildness of his offence, he was released on February 7, ten days before the revolution exploded.

On February 17, 2011, demonstrators filled the streets of Benghazi, in eastern Libya. The protests quickly turned violent when the regime attacked the crowds, and within days the armed uprising began. Over the following days, hundreds were killed as the army locked down the streets of the capital. The regime declared a general amnesty for common criminals and emptied jails to make room for political prisoners. Dissidents such as Tawati were rounded up – she was arrested and taken to Abu Salim. Rabia Ragoubi, the Linux group founder, was betrayed by a friend for his rebel sympathies; he was beaten and tortured with electric prods, then imprisoned for the remainder of the war.

By the beginning of March, the regime had shut off access to the internet, rendering the Eagle system for the most part deaf. Now, as the battle see-sawed between the regime and the rebels across Libya, the cyberwar would be directed outwards, committed to the task of distributing pro-Gaddafi propaganda to the world and shutting down any attempts by rebels to send out their own message. A senior official at the country's internet provider, Mohammed Bayt al-Mal, was put in charge of expanding the Electronic Army, which grew to about 600 members in Tripoli alone.

Nadia (not her real name) volunteered for the Electronic Army to protect herself after her uncle was arrested for helping protesters during the demonstrations. A dark-haired medical student, she submitted her ID papers and was accepted. She and other volunteers would sit at the 40 or so PCs in the office, making pro-Gaddafi images, posting propaganda videos and creating dozens of fake accounts to leave comments online.

On the second floor of the Electronic Army building, off-limits to ordinary members, there was a team of hackers, and occasionally she talked to some of them during lunch. They were getting paid to break into the email and Instant Messenger accounts of expat dissidents. Some hackers were foreigners. "Gaddafi doesn't trust you Libyans," one of them, a Palestinian, told her.

Despite the internet shutdown, it became clear that information was somehow getting out of Tripoli. At first the Electronic Army's own members were suspected. One day, Nadia says, Asian technicians came through to install monitoring gear in the factory where they all worked. The watchers would have to be watched.

But soon it was evident that the culprits were at large in the city. A memo from External Security, one of Libya's spy services, was sent out. "This is to inform you," it began, "that there is a group of people within Tripoli who call themselves the Free Generation Movement. They commit vandalism against the police and are distributing flags from the king's era. They have also done interviews with a number of journalists inside of Tripoli." Worse, the group had found a way to get videos of all this subversive activity online. They needed to be stopped.

Under the scorching May sun, Niz and Mokhtar Mhani wrestled a satellite dish into the back of their car. The two young men, cousins with identical close-cropped haircuts, had picked a time when no one would be at the office. They simply climbed up to the roof and unbolted the dish.

Niz and Mokhtar weren't stealing it for themselves. They were two leaders of the Free Generation Movement, an underground group of roughly a dozen young activists, founded in the wake of February 17. They had hoped the revolution would succeed peacefully, but after witnessing the brutal crackdown in the streets, they had decided to show the world that

Ali Hamouda in the room where he was interrogated by Libyan intelligence. The Amesys monitoring centre was housed in the same building

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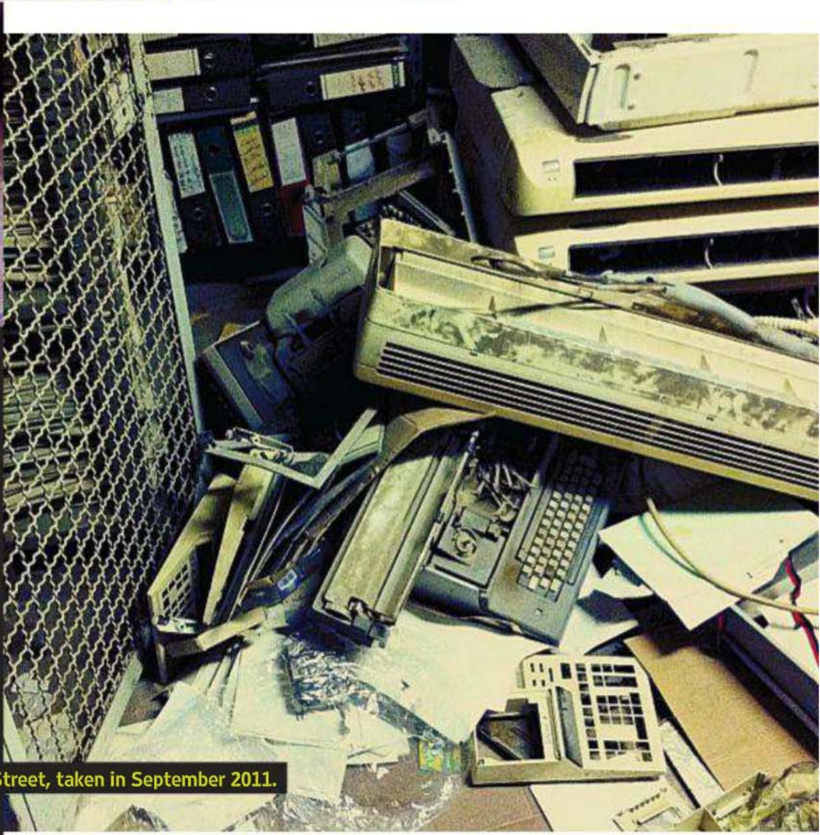


Tripolitanians opposed the regime and supported Nato's intervention. For that, they needed internet access. In a stroke of luck, Mokhtar had been able to hack into the satellite internet connection at his office, where he worked as a network administrator; by creating a secure VPN, he even set it up so that he and Niz could connect from home. When the satellite subscription ran out, they decided to steal the dish and set that up at home too, so there would be even less risk of discovery. A contact in Egypt could get them a new subscription.

At first, they used the dish to upload videos of themselves and friends staging mini-demonstrations in recognisable areas of the capital. Their videos went viral and were played on the rebel satellite TV channel. Before long, the Free Generation Movement became central to directing international press coverage about resistance in the capital. Thanks to that stolen dish, they had one of the few internet links out of Libya. So naturally the regime was hunting them.

One day in July, a Libyan girl named Isra Rais started chatting with Mokhtar through his Free Generation account on Facebook. He assumed that, since she had internet access and was chatting in English, she was an expatriate. Thanking him for his service to the country, she asked him for a photo.

He demurred. Could she call him on his phone, she asked. Again, Mokhtar declined. She asked for his address. Now suspicious, he gave her a phony reply. The mask dropped, and "Isra" wrote: "You are a traitor. When we catch you we gonna kill you."

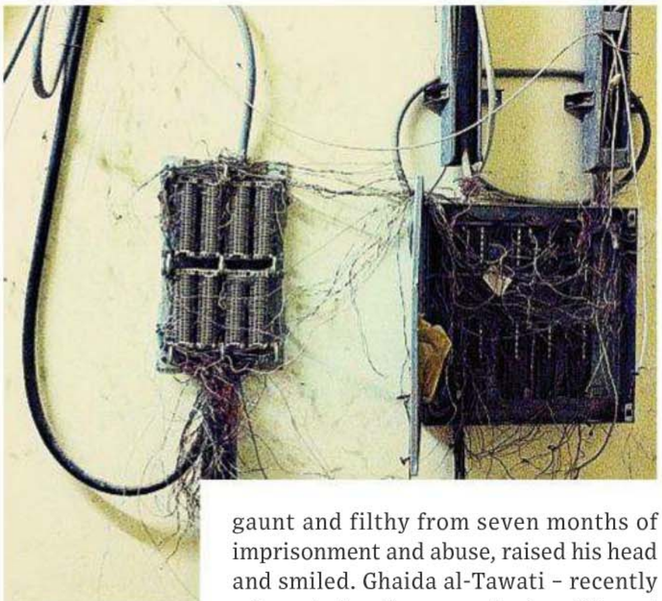
Photos from the "Heretics House", the intelligence building on Sikka Street, taken in September 2011. Shelves of pink folders held thousands of case files, transcripts of phone calls, and printouts of emails. At the fall of Tripoli, the spy centre was abandoned in a rush; jumbled piles of computer equipment and shredded documents were left behind

By this point, the regime's electronic warfare had become even more sophisticated. Calls had long been monitored, but now the spies turned their attention to satellite phones. To avoid Nato air strikes, one team of Ukrainian mercenaries set up shop in a children's nursery around the corner from the intelligence headquarters; from there they snooped on sat-phone traffic using frequency scanners. Gaddafi had declared that anyone caught with a satellite phone could be sentenced to death.

In the end, though, it was likely an email account that led Gaddafi's forces to the house of Mokhtar's parents. (Mokhtar believes the regime was monitoring the Free Generation Movement's private email address – libyaresistance@gmail.com – and that someone slipped and used Mokhtar's real name in an email.) His father and brother were arrested, and he and Niz went into hiding. The Free Generation Movement went quiet.

It would be the final chapter in Gaddafi's cyberwar. Around the country, the battle had turned in favour of the rebels, who were closing in on the capital. The noose was tightening around Tripoli.

At dusk on August 20, 2011, a cry rose up from the loudspeakers of the mosques of Tripoli: Allahu Akbar. God is great. For the past few days, a rumour had spread through the city that the signal for the final assault would come from the mosques. Now that call had arrived. In the cells of Ain Zara prison, Rabia Ragoubi,



gaunt and filthy from seven months of imprisonment and abuse, raised his head and smiled. Ghaida al-Tawati – recently released after three months in a different prison – watched as her brother and the men of their neighbourhood unearthed a cache of AK-47s they had hidden in the old Christian cemetery. She watched as her brother shouldered his rifle and ran off to join the battle in the presidential palace.

The intelligence chief was screaming at him: "You are an agent of foreign enemies!"

Over the next few days, all the important government sites fell into rebel hands. The prisons were liberated, the palace captured. Even the intelligence centres were forced to yield up their secrets. Later, researchers from Human Rights Watch and *The Wall Street Journal* obtained a massive cache of documents from their archives.

WIRED reviewed many of these documents and conducted extensive interviews with dissidents and former regime officials to reveal the extent of Gaddafi's spying on his people. Because the colonel, in his paranoia, liked to create multiple, rival agencies with overlapping capabilities, it's extremely difficult to get a comprehensive view of just how his surveillance empire was structured. There is, however, substantial documentary and eyewitness evidence of the involvement of a number of important multinational companies.

Amesys, with its Eagle system, was just one of Libya's partners in repression. A South African firm called VASTech had set up a monitoring centre in Tripoli that snooped on all international phone calls, gathering and storing up to 40 million minutes of conversations each month. ZTE Corporation, a Chinese firm whose gear powered much of Libya's mobile phone infrastructure, is believed to have set up a parallel internet-monitoring system for External Security: photos from the basement of a makeshift surveillance site, obtained from Human Rights Watch, show components of its ZXMT system, comparable to Eagle. US firms likely bear some blame as well. On February 15, just before the revolution, regime officials reportedly met in Barcelona with officials from Narus, a Boeing subsidiary, to discuss internet-filtering software. And the Human Rights Watch photos clearly show a manual for a satellite-phone-monitoring system sold by a subsidiary of L-3 Communications, a defence conglomerate based in New York. (Amesys, VASTech, ZTE and Narus did not respond to multiple interview requests; L-3 declined to comment.)

It's true that all these systems were sold to Gaddafi at a time when sanctions had been lifted and the regime was ostensibly collaborating with Western intelligence agencies. The export restrictions that limit the sale of arms to rogue nations do not currently cover this kind of surveillance gear, which is how some of it has turned up in countries like Syria and Myanmar, where Western weapons sales are forbidden. (A bill put before US Congress this year, the Global Online Freedom Act, could end this disparity for American companies. Also, in April, President Obama issued an executive order that authorised visa bans and financial restrictions against foreigners – or foreign companies – that provide surveillance technology to Iran or Syria.) "Massive intercept" technology has now become cheap and simple enough to export off the shelf, for sale to any government at a few tens of millions of pounds. You can run an approximation of *1984* from a couple of rooms filled with server racks. That's what Libya's spies did – and what dictatorships around the world continue to do.

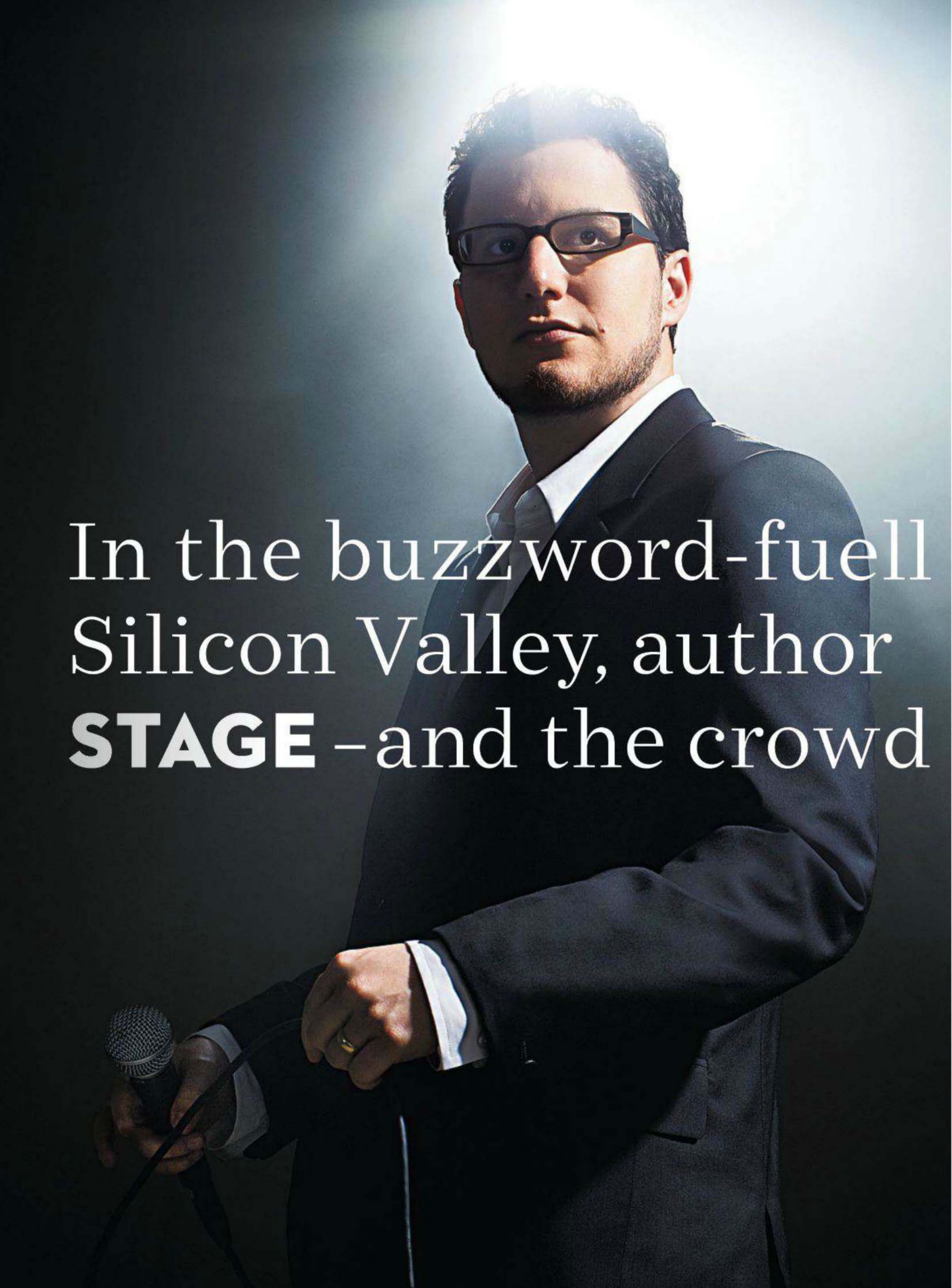
An uneasy peace now holds in Tripoli. Libyans are exuberant at having thrown off Gaddafi's rule, but the government is barely functional, and a patchwork of militias holds the capital. The city is full of strutting young men in mismatched uniforms, wielding weapons.

Niz has returned to the UK, but Mokhtar and the Free Generation Movement are active in Libya's fledgling civil society, where they've sponsored a campaign for disarmament, among other initiatives. Ragoubi is wracked by stress from his prison spell. Tawati, meanwhile, carries on attacking the corruption of the new government.

Ahmed Gwaider has gone to ground. A number of sources say that he has been called back to work for the new government – as an IT manager in the intelligence service. Reached by phone last December, he admitted to being a proficient hacker and having worked for the former regime, but he declined to talk specifics.

"I'm not going to implicate myself," he said. "Everything I did was for the country."

Matthieu Aikins has reported on Afghanistan and the Middle East for Harper's, GQ *and other publications*



In the buzzword-fuell Silicon Valley, author **STAGE** – and the crowd

ed arena of
ERIC RIES HAS THE
is GOING WILD

THE UPSTART

BY TED GREENWALD

PHOTOGRAPHY: ERIC OGDEN

Scott Cook is conducting an experiment. "It's the corporate-consulting version of speed dating," says the spectacled cofounder of Intuit, the finance software giant.

He's gathered his troops in a brightly lit conference room, where members of four Intuit departments are seated in front of 300 colleagues – plus 1,500 more watching via webcast – to hash out some problems. Each team will take five minutes to present its dilemma, then special guest Eric Ries will come up with a solution.

Arun Muthukumaran, a group manager of Intuit Payment Solutions, kicks off proceedings. He describes a feature that could dramatically increase the number of small businesses that sign up for the company's payment services. But implementation would burn up 20 employees' time for a month. What if customers don't bite?

Ries, dressed in a blazer, pastel shirt and black denim, suggests a test: rather than building the service and trying it out on customers, create a sign-up page that merely promises to deliver this groundbreaking capability. Then present it to some prospective clients. Compare their enrolment rate with that of a control group shown the usual sign-up page. The results will give the team the confidence to proceed or toss the idea into the circular file. No one would actually get the new feature yet, of course, because it hasn't been built. "I guess we could piss off a few customers instead of thousands," Muthukumaran says. Laughter ripples through the crowd.

Ries glances at his watch. "It's 4.18pm on Monday," he says with a grin. "On Wednesday at 4.18pm, I expect an email telling me how it went." The team members exchange glances that are equal parts bemusement and worry: they make software, not concepts. They build code through painstaking cycles of design, programming and testing. Customers depend on their products and trust their brand. And this guy expects them to offer a feature that doesn't even exist? Nevertheless, the other employees are exhilarated. The room breaks into fervent applause.

It's something Ries is getting used to. At 33, he is Silicon Valley's latest guru. In the four years since he first posted his theories about running startups on an anonymous blog, his campaign to replace the typical product-development approach – build it and they will come – with a system based on experimentation has become a juggernaut. Ries's book *The Lean Startup*, published last summer, has sold 90,000 copies in the US. His blog, Startup Lessons Learned, has 75,000 subscribers, and his annual conference attracts 400 entrepreneurs, each paying more than $500 (£300). Harvard Business School has incorporated his ideas into its entrepreneurship curriculum, and an army of followers is propagating his principles through their own books, events and apps. Whizz-kids looking for investors pepper their PowerPoint decks with Lean Startup lingo, which has become so pervasive that TechCrunch announced a ban on Ries's term "pivot". Tech darlings such as Dropbox, Groupon and Zappos serve as Lean Startup poster children, and now the philosophy is reaching established companies, including GE and, this afternoon, Intuit.

Back in the hall, Ries walks his audience through his philosophy. The core motivation is simple, and a single slide sums it up: "Stop wasting people's time". Entrepreneurs and their managers, minions, advisers and investors routinely pour their lives into products nobody wants. The business landscape is littered with the wreckage of nascent companies built at monumental effort and expense that imploded on contact with the market. (Paging Webvan! 3DO! Iridium!) Unlike an established company, a startup (or a new division within an established company) doesn't know who its customers are or what products they need. Its prime directive is to discover a sustainable business model before running out of funding.

The key to this discovery, Ries proposes, is the scientific method: the business equivalent of clinical trials. Assumptions must be tested rigorously, Ries says – and here he rolls out one of those increasingly ubiquitous Lean Startup phrases – on a "minimum viable product", or MVP. This is a simplified offering that reveals how real customers, not cloistered focus groups, respond. It may be a functional product or, like the Intuit team's sign-up page, a come-on designed to elicit a reaction. Once tallied, customer responses produce "actionable metrics", as opposed to popular "vanity metrics", which create the illusion of success but yield little useful information about what customers want. By repeatedly cycling or "iterating" through a "build-measure-learn loop" – a method Ries calls "validated learning" – the Lean Startup develops a verified perspective that enables it to identify and fine-tune the mechanism that will keep the company growing, aka its "engine of growth". Or, failing that, it can "pivot" to a new strategy. This, Ries insists, is the quickest, most efficient route to "product/market fit" (a phrase from Silicon Valley kingpin Marc Andreessen),

LEAN STARTUP LINGO

You can't roll down your BMW's windows in the Valley without overhearing someone spouting jargon popularised by *The Lean Startup*. Here's a cheat sheet. Katie M Palmer

STYLING: DANNY O'NEILL/ARTISTS UNTIED; SUIT BY GIVENCHY; SHIRT BY THEORY. GROOMING: VERONICA SJOEN/ARTISTS UNTIED

defined as the moment when a product achieves resonance with customers. Never mind that this approach is a mashup of ideas culled from programming, marketing, manufacturing and business strategy, leavened with hard-won insights that have circulated among Silicon Valley veterans for years. Ries makes no effort to hide his sources, and his presentation preempts his critics' complaints. "Lean", he explains, does not mean cheap; it means eliminating waste by testing ideas first. And it doesn't mean small, but rather that companies shouldn't ramp up personnel and facilities until they've validated their business model. His philosophy is not only for internet and app companies – that's just where it started. Reacting to customer behaviour is not incompatible with creating breakthrough products such as the iPhone, Ries says, which in the popular imagination sprang fully formed from the mind of Steve Jobs.

Right or wrong, the Lean Startup has a kind of inexorable logic, and Ries's recommendations come as a bracing slap in the face to would-be tech moguls: test your ideas before you bet the bank on them. Don't listen to what focus groups say; watch what your customers do. Start with a modest offering and build on the aspects of it that prove valuable. Expect to get it wrong, and stay flexible (and solvent) enough to try again and again until you get it right.

It's a message that rings true to grizzled startup vets who got burned in the Great Bubble and to filmgoers who left *The Social Network* with visions of young Zuckerberg dancing in their heads. It resonates with web entrepreneurs blessed with worldwide reach and open-source code. It's the perfect philosophy for an era of limited resources, when "optimism" is necessarily preceded by "cautious". In a highly connected, recession-ravaged economy, Eric Ries has created a story so persuasive that the Lean Startup may already be too big to fail.

Ries was fresh out of Yale with a BS in computer science in 2001 when Will Harvey, cofounder of a startup called There.com, plucked his CV from a tall stack. Ries was an impressive candidate. He'd published a book (*Black Art of Java Game Programming*) while still in high school, and started a company that had actually received funding (CatalystRecruiting.com). There.com was a virtual world along the lines of *Second Life*, where members interacted through 3D avatars. The young engineer quickly demonstrated an unusual quality: "He wanted to help everyone," Harvey recalls. "He could understand someone else's problem and solve it in a miraculously short period of time."

There.com made a high-profile debut in 2003. But the public yawned, and poof – $50 million (£31 million) and years of dogged effort vanished. The following year, Harvey launched his next venture, a site called IMVU, which aimed to populate chat networks with 3D avatars. He brought Ries aboard as CTO. He also roped in There.com investor Steve Blank. A Silicon Valley legend, Blank had played a founding role in eight tech companies before withdrawing to the less stressful life of a university professor. He agreed to fund Harvey's new company on one condition: that its top executives audit his entrepreneurship course at UC Berkeley. For Ries, the class was a revelation. In the conventional view, startups are smaller versions of established companies, Blank explained. But they're not. Established companies know what to make and who will buy it. Startups don't. When neither the product nor the customers are known, understanding the audience demands as much rigour as creating the product: it requires something Blank called customer development. Focus groups won't do. The only solution is to put real features in front of customers, track their response, rinse and repeat until the product gains traction. Ries was already a convert to agile software development. At the time he joined IMVU, most software projects used the waterfall method – programs were fully specified, built, tested and deployed in one long, sequential march. The agile method, on the other hand, emphasises rapid development and responsiveness to user needs. Designs evolve alongside user feedback, and products metamorphose through repeated cycles of design, development and deployment. Ries realised that Blank's process could augment agile software development by enabling IMVU to cycle rapidly through customer development in parallel with product development.

Ries spent the next four years fusing techniques from Blank's self-published handbook *The Four Steps to the Epiphany* with ideas gleaned from Kent Beck's *Extreme Programming Explained*, the lean-manufacturing study *The Machine That Changed the World*, and Geoffrey A Moore's marketing classic, *Crossing the Chasm*. Fuelled by these insights, IMVU tested unorthodox ways to learn who its customers were and what they wanted.

At first the company raced to develop a minimum viable product, only to find that no one wanted to download it. Ries realised that he could have learned the same thing from a simple description of the product and a Download Now! button. Using Google's AdWords programme, which allows anyone to buy internet traffic at a low price, he budgeted $5 a day to attract 100 visitors. Ries shunted them through various designs and compared the differences in their behaviour (a practice called split or A/B testing – see issue 06.12). He tracked the shifting percentages as visitors registered, logged in, used the product and upgraded to the paid version (known as cohort analysis). And he practised something he called continuous deployment, updating code as frequently as 50 times a day. After many false starts, IMVU prospered.

A new CEO arrived in 2008, and Ries decided to move on. Word of his innovative derring-do had made its way to VC firm Kleiner Perkins, which gave him a job: venture adviser. It was a place to hang his hat while he worked out what he wanted to do. But he never felt comfortable there. "Fundraising strategy should be an outcome of business strategy, not the other way around," he says. Six months later he went indie as a business consultant. One of his first clients was IMVU investor and superangel Mike Maples. "At lunch in summer 2008," Maples recalls, "Eric said, 'I'm working on this new set of ideas called the Lean Startup. What do you think?' He showed us a bunch of raw slides. We said, 'This is cool! This framework could have legs.' He said, 'If this works out, I won't just consult. Maybe there's a book to be written.'"

Other clients weren't so receptive. "I would tell stories of what we did at IMVU, and they would look at me like I was a lunatic," Ries says. Tired of justifying his advice, he decided to start a blog. "Then I could say,

MINIMUM VIABLE PRODUCT (MVP)

The cheapest, easiest offering you can put before potential customers that will allow you to gauge their interest. Classic example: Dropbox's video showing all the wonderful things its (still unreleased) service could do.

PIVOT

A shift, often radical, in a startup's strategy. For example, if your tablet magazine doesn't take off, try selling your software to other publishers.

VANITY METRICS/ ACTIONABLE METRICS

Instead of using misleading "vanity" metrics – the number of registered users, for instance – startups should focus on "actionable" metrics, stats that demonstrate clear cause and effect.

'Read this essay. If you think I'm crazy, don't hire me.'" Initial posts on the blog, Startup Lessons Learned, were anonymous. Then, to the author's surprise, a trickle of readers started showing up, mostly hungry young entrepreneurs who came across the site while searching Google for guidance. True to Blank's customer-development credo, Ries asked them what they wanted to get out of his writing: "Lo, my 5 subscribers," he addressed them in September 2008. The response was unequivocal: they wanted to know who he was and why they should take him seriously. It was time to pivot from private adviser to public pundit. So in October, after two months of anonymity, he peeled off the mask and revealed his identity.

Then the economy tanked. Sequoia Capital issued a presentation to portfolio companies titled "RIP Good Times", advising CEOs to "spend every dollar as if it were your last". There couldn't have been a better advertisement for a philosophy called the Lean Startup, and a rising tide of distressed entrepreneurs found their way to Ries's blog. Suddenly Ries was in high demand. Executives requested meetings. Publisher Tim O'Reilly invited him to speak at the Web 2.0 Expo. Harvard Business School offered Ries a spot as entrepreneur-in-residence. Lean Startup Meetup.com groups sprang up in cities across the globe. In his November reader survey, Ries called out: "Lo, my 1,032 subscribers." By January 2010, with his posts ricocheting among startup blogs and business sites, he had 18,891 followers. And, by September, 57,692.

The Lean Startup had escaped into the wild, where it was mutating into events, courses, software tools and blogs. But Ries was more interested in propagating his ideas than controlling them. He trademarked the name to stop scam artists, but he resolved not to charge anyone who used it honestly. He publicised meetups on his blog and went out of his way to attend their initial gatherings.

One hectic year after his first blog post, he was ready to push the Lean Startup out of its beginnings in Silicon Valley and into the mainstream. Published in September 2011, *The Lean Startup* debuted at an impressive number two on the *New York Times* advice best-seller list.

ON AN UNSEASONABLY WARM JANUARY DAY, DOGPATCH LABS SWARMS like an anthill. Fifty would-be entrepreneurs have come to Palo Alto from as far away as Finland for an event called Lean Startup Machine (LSM). This is not an Eric Ries production but a hackathon of sorts organised by 24-year-old impresario Trevor Owens. Participants form teams, rally around a product idea and then test it. Next they "pivot or persevere" (a Ries adage) based on what they learn, aiming to complete as many revolutions around the build-measure-learn sequence as possible before Sunday night. The team that demonstrates the most validated learning wins workspace, legal services and consulting from LSM mentors.

Ries was aghast when Owens emailed in mid-2010 asking him to appear at the first LSM. "I said it's fundamentally wrong to judge a startup in 48 hours," he recalls. But Owens persuaded him to participate, and Ries was amazed by what he saw: teams pivoting several times, learning in three days what might otherwise take months.

For the January event, Ries Skypes in from the UK – he's speaking at the London School of Economics and going to Ireland to launch the Dublin meetup group – for a 30-minute pep talk. Whereas Ries spent his childhood programming multiuser dungeons, today's entrepreneurs, coming of age in the era of *Angry Birds*, have everything they need to create the next Twitter or Zynga. They can cadge open-source software from SourceForge, rent processing power from Amazon Web Services, buy traffic

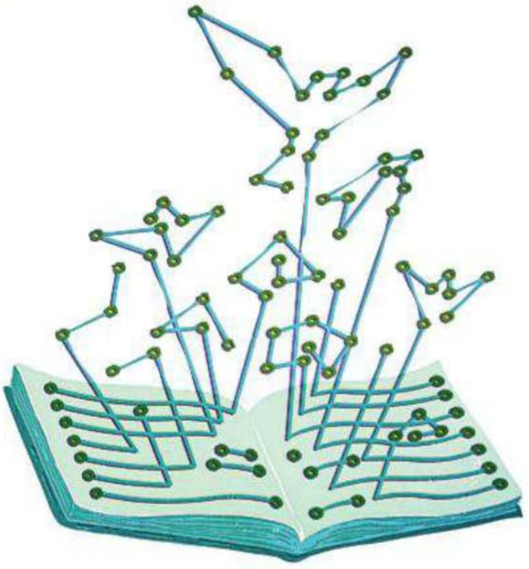


ILLUSTRATION: GARY MUSGRAVE

SACRED TEXTS OF HIGH TECH

Eric Ries's *The Lean Startup* follows a long tradition of books by Silicon Valley gurus that promise to light the path to success. KMP

***CROSSING THE CHASM* (1991)**
GEOFFREY A MOORE

In perhaps the first book targeted at the Silicon Valley startup set, Moore guides entrepreneurs across the chasm that lies between early adoption and the mainstream market.

***THE INNOVATOR'S DILEMMA* (1997)**
CLAYTON M CHRISTENSEN

The book that made disruptive technology a Valley buzzphrase explains why bad things sometimes happen to good companies, and when management should jettison traditional business practices.

***BLUE OCEAN STRATEGY* (2005)**
W CHAN KIM AND RENÉE MAUBORGNE

Resurrecting Christensen's idea of disruption, this urges businesses to escape the red, bloody ocean of competitive markets for a blue ocean of uncontested market dominance. (See p85 for a condensed version.)

***THE FOUR STEPS TO THE EPIPHANY* (2005)**
STEVE BLANK

Blank's work revolves around his "customer development" model, which urges businesses to build customers, not just products. Ries has called it one of the pillars of the Lean Startup.

***BUSINESS MODEL GENERATION* (2010)**
ALEX OSTERWALDER AND YVES PIGNEUR

This collaborative effort between the authors and 470 "practitioners" breaks down all business models into nine interrelated components. The results clarify an often murky topic.

The Lean Startup escaped into the wild, **WHERE IT MUTATED** into events, courses, software and blogs

from Google and distribute through the App Store. The Lean Startup gives them a guide to spinning these resources into gold. Indeed, LSM is buzzing. One group is posting ads on Craigslist to test demand for a scam-free classified ad market. The team that calls itself CrowdJewel spams the Etsy ecommerce network to promote a jewellery-design contest. Participants are shooting demo videos, mocking up screens for mobile apps, bolting together open-source code and researching cloud-computing resources. They're also cranking out online ad campaigns for products that don't exist and web pages featuring bogus Buy buttons. The absence of real products is not a problem, Ries tells them. Don't worry about negative fallout from an undercooked MVP – a follow-up apology will mollify mainstream customers and actually make early adopters more enthusiastic by letting them in on the product's genesis.

This degradation of the minimum viable product into blatant deception is one of several axioms that rankle Ries's admirers and critics alike. For instance, the Intuit Payment Solutions employees working on their promising new feature ultimately decided they felt uncomfortable misleading customers. Instead, they invited a select group via email to participate in a private beta.

Other aspects of the Lean Startup philosophy have met with more vocal opposition. While debating with Ries at a startup conference, David Heinemeier Hansson, creator of the Ruby on Rails programming tool, professed the credo, "We only build software for us." Ben Horowitz, cofounder of the VC firm Andreessen Horowitz, picked up the baton with a blog post titled "The Case for the Fat Startup", arguing that smart entrepreneurs don't conserve capital; they raise enough cash to crush competitors. Defenders say that Horowitz was misinterpreting Ries's use of the word lean, but the feeling lingers that the Lean Startup philosophy trades vision for plodding validation. "The whole philosophy is barren and derivative," says Keith Rabois, the superangel and ex-PayPal exec who now serves as COO of Square, a service that allows anyone to accept credit cards. It's incapable, he says, of inspiring companies such as Apple or Tesla, which have made the words "startup" and "innovation" synonymous.

Ries doesn't see any contradiction between visionary leadership and sussing out the market through experimentation. "The Apple I was a classic MVP," he says with a shrug. Steve Jobs cycled through designs until he hit on one that clicked. A method wasn't available to turn his experimentation into a structured process; he had to rely on intuition and browbeat his organisation into following it. "The next generation will have the tools to prove they're on the right track," Ries says. "They won't have to deal with that kind of bullshit."

Not that the LSM participants have come up with an Apple this weekend. As Sunday draws to a close, Owens proudly announces the winner: CrowdJewel. Headed by Courtney McColgan, an entrepreneur-in-residence at Morgenthaler Ventures, the team staged a 15-hour jewellery competition that attracted 75 designs from 14 countries and garnered 600 votes. After announcing a victor in its contest, it confirmed one sale by tracking traffic from its landing page to the designer's site. The only negative indicator: Googling the term "CrowdJewel" leads to a discussion about whether the company is a scam.

FOR ALL THE LEAN STARTUP'S EMPHASIS ON THE SCIENTIFIC method, no one knows whether it really works. A case can be made that the companies cited as Lean Startup success stories aren't strictly evidence of Ries's wisdom. Dropbox famously debuted with a video of a beta of its yet-to-be-released product – spurring 70,000 users to sign up for the service within 24 hours. But the company didn't base its whole strategy on Lean Startup principles.

Ries is confronting the question head-on. Determined either to validate the efficacy of his theory or iterate his way to something more effective, he has teamed up with Nathan Furr, an assistant professor of entrepreneurship at Brigham Young University, to subject the Lean Startup to rigorous analysis. Furr is hammering out before-and-after case studies and examining correlations between learning, shifts in strategy and performance.

But Ries's apostles aren't waiting for data. Top business schools are cranking out candidates for the next generation of Lean Startup case studies. Tom Eisenmann is leading 100 Harvard MBA students through Lean Startup principles in his course Launching Technology Ventures. Some 80,000 people signed up to take Steve Blank's Lean LaunchPad, a ten-week online boot camp. The National Science Foundation is funding him to do the same with a hand-picked corps of scientists and engineers. And the Lean Startup is advancing into the public sector. Tim O'Reilly, as board member emeritus of the nonprofit, Code for America, is pushing Ries's ideas into municipal governments. "We're teaching cities to use the Lean Startup approach instead of a year-long procurement process," he says.

If Ries can keep the movement yoked to the scientific method, it might just isolate principles that steer firms toward real, lasting, massive success. Until that happens, he will stay a reluctant guru. "The movement needs a face, and if it has to be me, I can accept that. But I'd be happier if it could be the faces of the entrepreneurs doing the real work of figuring out whether these ideas are true."

Which is not to say he isn't enjoying the ministry. "I will do this as long as it's having an impact and it remains intellectually interesting," Ries says. "So far, it's off the charts on both fronts. If it turns out to be a fad, I'll go back to what I was doing before." After all, he's comfortable with failure. It's the only way to learn.

Ted Greenwald blogs at blogs.forbes.com/tedgreenwald

ERIC RIES ADVISES...

"Every startup has a chance to change the world, by bringing not just a new product, but an entirely new institution into existence."

"The hard part is to figure out the fewest possible features that could possibly accomplish your company's goals."

"Most founders have horrifically bad ideas at the start."

"The products a startup builds are really experiments. Each experiment essentially follows a three-step process: Build, measure, learn."

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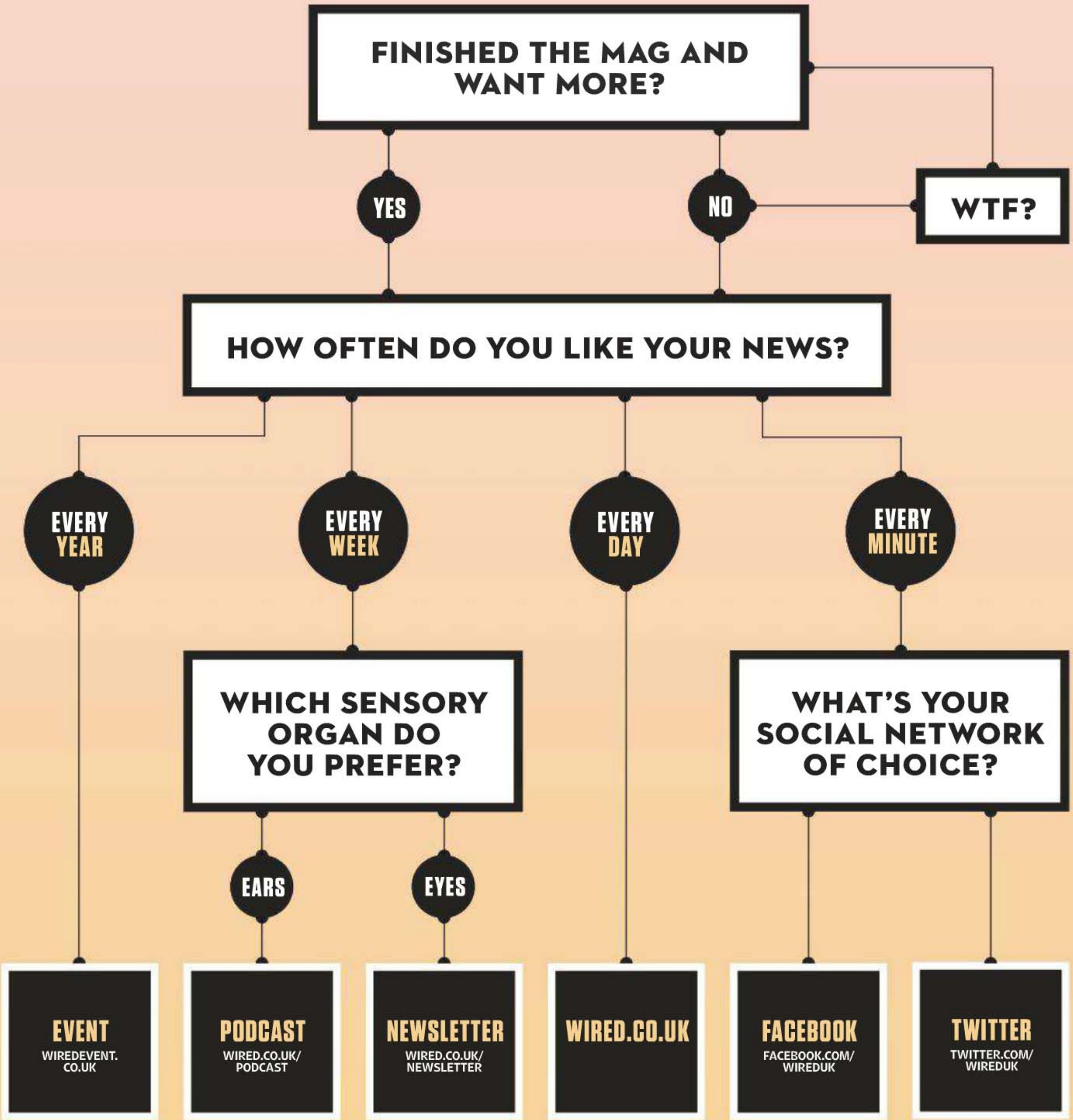

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EVERY DAY

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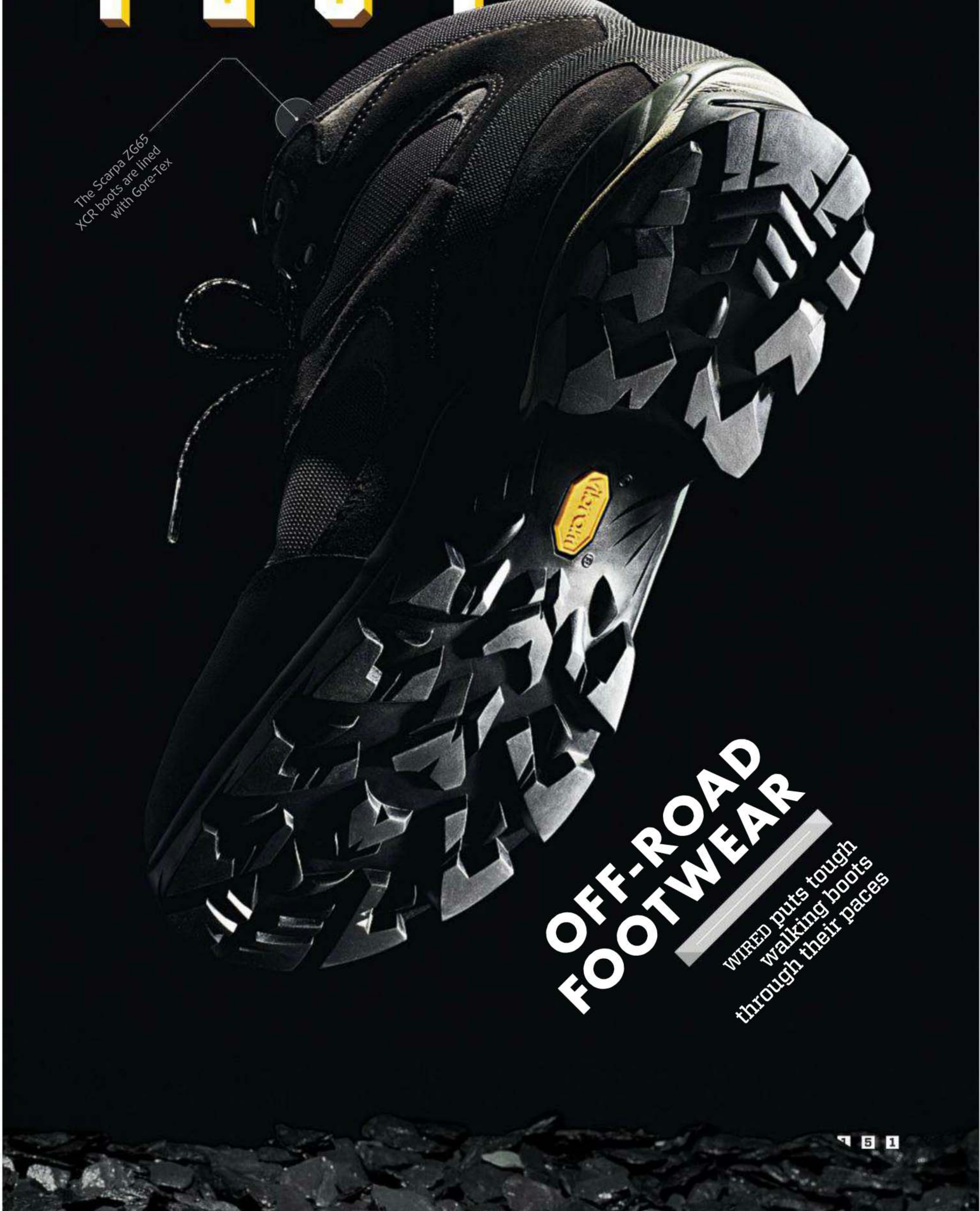
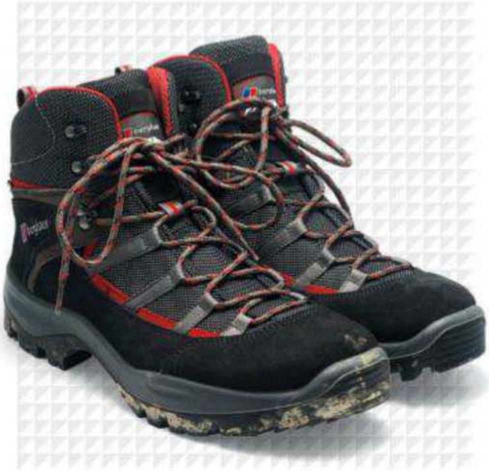


The Scarpa ZG65 XCR boots are lined with Gore-Tex

OFF-ROAD FOOTWEAR

WIRED puts tough walking boots through their paces

PHOTOGRAPHY: SUN LEE



BERGHAUS EXPLORER LIGHT

These boots may not be exciting to look at, but they perform well thanks to the flexible outer sole that pivots and bends on uneven ground. They provide decent ankle support, good water-repellency and are easy to get on and lace up in a hurry. Podiatrist and tester Mark Freedman liked the padding but thought the insole to be "too soft and lacking arch support". The outer soles provide excellent grip in the wet but are the softest in our group test, and so are likely to wear out the soonest. The stitching of the nylon lace-loops looks to be the least durable, too.

WIRED Comfy padding

TIRED Least durable

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£110 berghaus.com

MEINDL AIR REVOLUTION LITE

This attractive design combines durable leather-and-suede uppers with rubberised heel, toe and side protection. The leather lace-loops look well stitched but the laces are hard to gather tightly. "The boot feels heavy with the least flexibility and flattest profile," says Freedman. Although not the comfiest boots, they still offer effective protection, temperature control and water repellency.

WIRED Stylish; tough

TIRED Stiff; pricey

■■■■■■■□□□

£185 meindl.co.uk

HOW WE TESTED

Ramblers Susie Parker and Adrian Justins hiked across the South Downs to test comfort. Mark Freedman of the Chingford Podiatry Centre (sorefeet.co.uk) checked protection and support. We also put the boots in water and noted the depth needed to breach each model.

SCARPA ZG65 XCR

This elegant boot has decent toe and heel protection, impressive lack of weight and a strong, flexible sole. The leather lace-loops don't look durable, and the shortage of hooks means it's hard to get proper tightness. General comfort is good on all but very rugged terrain – you should stay clear of deep puddles, though. Freedman's considered final assessment: "The XCR's soles have good flexibility but the soft insole is, frankly, rubbish."

WIRED Strong sole

TIRED Loose lacing

■■■■■■□□□□

£135
cotswoldoutdoor.com

SALOMON QUEST 4D GTX

Sturdy, with all the hallmarks of a good three-season boot, the Salomon has few obvious flaws – until you put them on and find the laces are thin and hard to grip. The lace-hooks look strong and the tongue can be folded to tighten the fit. Freedman liked the shock absorption but thought the sole may be too rigid. A smart blend of protection and comfort, these keep feet dry and cool for a reasonable price.

WIRED Good value; comfy and supportive

TIRED Skinny laces

■■■■■■■■□□

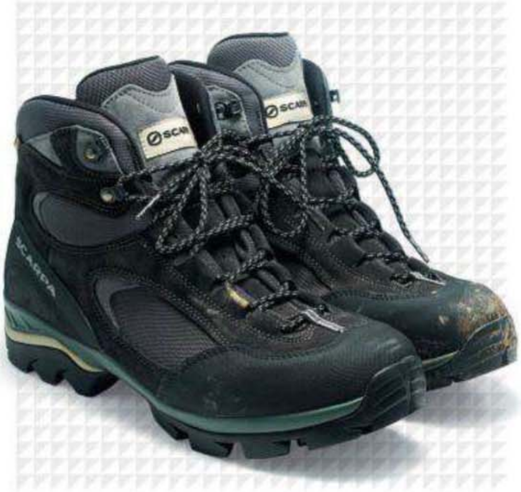
£155
cotswoldoutdoor.com

HOW WE RATE

1. A complete failure in every way **2.** Barely functional – don't buy it **3.** Serious flaws – buy with caution **4.** Downsides outweigh upsides **5.** Recommended with reservations **6.** A solid product with some issues **7.** Very good, but not quite great **8.** Excellent with only a few niggles **9.** Nearly flawless – buy it now **10.** Metaphysical product perfection

STEPPING UP THE STATS

	BERGHAUS	MEINDL	SCARPA	SALOMON	MERRELL
VOL. OF WATER REQUIRED TO BREACH BOOT	6.8L	5.2L	5.4L	6.5L	5.2L
SOLE GROOVE-DEPTH	7MM	5MM	5MM	11MM	8MM
NUMBER OF LACING GROMMETS	14 (8 NYLON, 6 METAL)	14 (8 LEATHER, 6 METAL)	12 (8 LEATHER, 4 METAL)	14 (2 LEATHER, 6 PLASTIC, 6 METAL)	10 (ALL METAL)
WEIGHT (PER BOOT)	636G (SIZE 11)	830G (SIZE 11)	740G (SIZE 11)	764G (SIZE 11)	380G (SIZE 7)
TOE ELEVATION	27MM	21MM	35MM	23MM	38MM
HEEL DEPTH	42MM	44MM	45MM	41MM	38MM



PHOTOGRAPHY: SUN LEE; DAVE LIDWELL. WORDS: ADRIAN JUSTINS

BOOT CAMP

Hiking footwear faces extreme testing from this month's team of tough-terrain experts

MERRELL AVIAN LIGHT MID SPORT GTX

This boot is designed for female hikers, is made of predominantly synthetic material and features a highly flexible sole. Freedman's podiatric opinion: "The fulcrum is good but I doubt if it will hold its shape. I would prefer a firmer sole." He praised the insole and the overall springiness of the shoe, but expressed concern about the thin heel. Our other tester, rambler Susie Parker, agreed, describing the boots as being "as comfy as a pair of slippers – until your heel lands on a stone". Water-repellency is also unimpressive.

WIRED Comfy for walks on even ground

TIRED Sole too flexible

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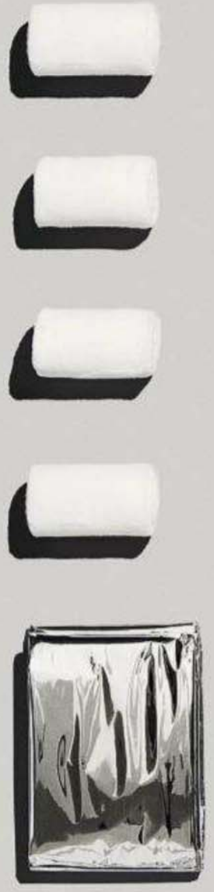
£125 merrell.com

The grip is by Vibram, who pioneered the use of rubber in climbing shoes



TREAT YOURSELF

WIRED comes to the rescue with medipacks for minor mishaps

STEROPLAST PREMIUM 70-PIECE FIRST-AID KIT BAG

Our tester, qualified first-aider Anita Thorpe, loved the foil blanket, which is useful if a patient needs keeping warm or goes into shock. It was the only kit that featured ice packs, which are ideal for soothing injuries such as sprains. Thorpe was impressed, but added, "Metal tweezers for removing splinters and an absorbent pad in case someone is bleeding would have completed the kit." The bag is roomy enough to add your own extras.

WIRED: Practical
TIRED: Missing bits
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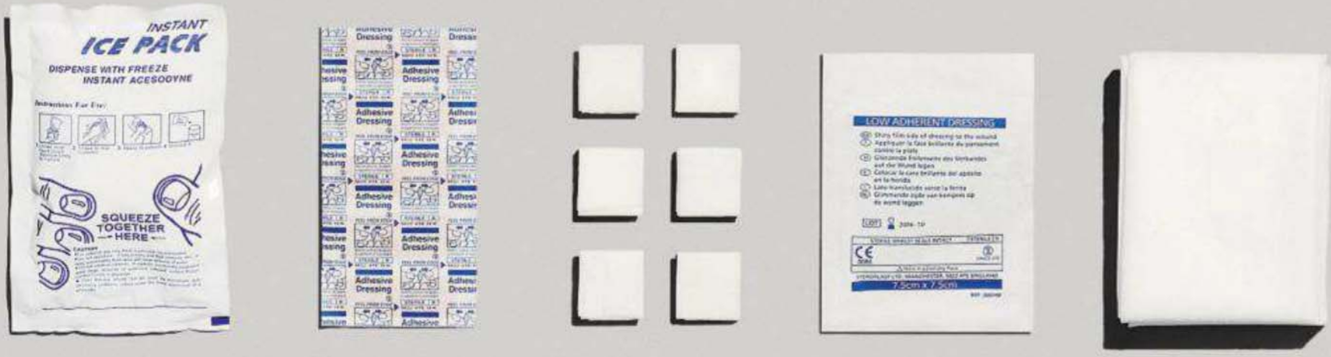
£10 steroplast.co.uk



SUPPORTING STATISTICS

	STEROPLAST	ST JOHN AMBULANCE	FIRSTAID-4SPORT	LIFESYSTEMS	FASTAID
NUMBER OF BANDAGES AND DRESSINGS	17	6	8	7	6
NUMBER OF ITEMS	70	33	23	55	45
PLASTERS	30	20	10	10	24
BAG DIMENSIONS	28 X 20 X 8cm	20 X 13 X 6cm	23 X 18 X 7cm	20 X 14 X 7cm	12 X 18 X 6cm
WEIGHT	780g	430g	435g	595g	295g

ST JOHN AMBULANCE HOME FIRST-AID KIT

The soft green pouch feels durable and looks professional and smart. The kit's contents are easy to access and features enough tools – such as the large and medium dressings, cleansing wipes and gloves – to make it ideal for domestic and minor traffic accidents. There is room in the bag for painkillers and antibiotics but this is still good value for money without them.

WIRED: Smart looks

TIRED: No scissors

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£9.30

stjohnsupplies.co.uk

HOW WE TESTED

With the guidance of Anita Thorpe, a qualified first-aider and an operating department practitioner at Yeovil District Hospital, we used a selection of current first-aid kits to treat common accidents. Dressings, bandages, scissors, swabs etc were all tested for quality and the packs scored on contents, design and value for money.

PHOTOGRAPHY: SUN LEE; DAVE LIDWELL. WORDS: EMILY PECK

FIRSTAID-4SPORT HOME FIRST-AID KIT

This pack is ideal for immediate application at home or on the playing field thanks to the inclusion of an ice pack and sling to treat sprains. Our medical expert praised the ice pack, which is ideal for sports injuries, and the generous number of plasters, gloves and dressings included. The absence of a basic first-aid book might be a problem – for instance, if you don't know how to tie your sling in the first place.

WIRED: Great value

TIRED: No guide

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£4.48

firstaid4sport.co.uk

LIFESYSTEMS MOUNTAIN FIRST-AID KIT

Designed for places where medical supplies aren't available, this first-aid kit was put together with the help of expedition doctor Hugh Montgomery and members of the British Special Forces medical team. Thorpe liked the clear pockets with antiseptic wipes, burn gel and gauze swabs, tweezers and the ample amount of dressings, plasters and tape. "You do, however, need an A level in *Tetris* to get the contents into the bag," she says. The kit also includes ibuprofen pills, which need to be monitored for use-by date.

WIRED: Lots of kit

TIRED: Tight squeeze

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£30

cotswoldoutdoor.com

FASTAID ESSENTIALS FAMILY FIRST-AID KIT

With its compact, waterproof case, this kit provides first-aid content suitable for domestic use, days out or camping. It features all the basics such as antiseptic cream, dressings, bandages and scissors. Our tester thought the cleansing wipes weren't moist enough to wipe the skin properly – saline or water pouches are more useful for rinsing dirty wounds.

WIRED: Waterproof

TIRED: Latex gloves may provoke allergy

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£10.72 amazon.co.uk

Search

TUNED IN

With video-on-demand, apps and motion control, these TVs are smarter than the average

SAMSUNG UE46ES8000

Samsung has packed plenty of innovations into its new ES8000 series. Particularly envelope-pushing are the improvements to its Smart TV interface. The TV also has very effective voice recognition. Gesture control is less successful, needing too much precision. But sumptuous onscreen menus, reams of apps and online video services, plus excellent 2D and 3D picture quality ensure that this is another irresistible Samsung proposition.

WIRED Stunning design

TIRED Gesture confusion

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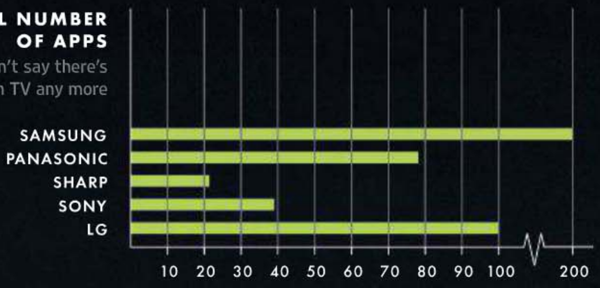
£1,900 samsung.co.uk

TOTAL NUMBER OF APPS

You can't say there's nothing on TV any more



ESSENTIAL APPS

SAMSUNG
DEDICATED FITNESS, NETFLIX, LOVEFILM, BBC IPLAYER, ACETRAX

PANASONIC
ACETRAX, BBC IPLAYER, FETCHTV, BBC NEWS, EURONEWS

SHARP
OPEN WEB BROWSER, BOX OFFICE 365, YOUTUBE, CARTOON NETWORK

SONY
LOVEFILM, TWITTER, SKYPE, FACEBOOK, QRIOCITY MUSIC

LG
BBC IPLAYER, LOVEFILM, TWITTER, FACEBOOK, YOUTUBE

A Login B Wallpaper Tools Return

PHOTOGRAPHY: SUN LEE. WORDS: JOHN ARCHER

IN THE PICTURE

	SAMSUNG	PANASONIC	SHARP	SONY	LG
SCREEN SIZE	46in	42in	60in	46in	55in
SCREEN TECH	LCD with edge LED lighting	LCD with edge LED lighting	LCD with edge LED lighting	LCD with direct LED lighting	LCD with edge LED lighting
HDMI PORTS	4	4	4	4	4
POST-CALIBRATION GAMMA (2.20 IDEAL)	2.22	2.29	2.29	2.22	2.29
SRGB COLOUR SPECTRUM REPRODUCTION	94%	98%	97%	97%	95%

PANASONIC TX-L42ET5

The TX-L42ET5 delivers an engaging 3D performance, hindered only by having a limited vertical viewing angle and slightly reduced 3D resolution. It's also a likeable 2D performer, and uses built-in Wi-Fi to access Panasonic's latest Viera Connect online portal. This features video services and surprisingly console-like games, but its interface feels dated – and more English-language content would be nice (Panasonic claims it's in the pipeline).

WIRED Good looks

TIRED Blurry 3D

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£899 panasonic.co.uk

SHARP LC-60LE636E

Sharp has recently realised that it's uniquely equipped to flog unbelievably large TVs for unfeasibly little money. The giant 60LE636E actually boasts Sharp's AQUOSNet+ online platform. A shame, then, that AQUOSNet+ turns out to be painfully short on content, not even running to the BBC's *iPlayer* at the time of writing.

WIRED Huge screen

TIRED Little content

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£1,499 sharp.co.uk

SONY KDL-46HX923

Instead of the usual edge LED lighting, Sony's 46HX923 uses more expensive direct LED lighting behind the screen. This delivers brilliant pictures, especially where contrast is concerned. The 46HX923 also excels with online content, thanks to a focus on streaming video rather than lots of apps. It is, after all, a TV, not a smartphone.

WIRED Vivid picture

TIRED Tedious menus

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£1,700 sony.co.uk

HOW WE TESTED

All TVs were tested using the same 6Mbps broadband for Smart features. Pictures were tested using the same Blu-ray and TV shows. Images were calibrated and colour performance measured with the Spyder4Elite system.

LG 55LM660T

LG has worked hard on its Smart TV functionality, adding genuinely useful video services (as well as many less useful apps) and making the interface more attractive and intuitive. All of which results in what's comfortably LG's best TV yet. Its design is sensational, thanks to its "barely there" bezel and super-skinny rear. Backlight inconsistency is an occasional niggle.

WIRED Excellent 3D

TIRED Poor lighting

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£2,200 lge.co.uk

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Lost in translation:
The works of Play editor Tom Cheshire have made it into some our international sister publications – and deservedly so.
However, the long journey for his byline is sometimes perilous...
WIRED Germany: "Tom Chesire"
WIRED Japan: "TC"
WIRED Italy: No credits

Office popularity:
TUC biscuits with the powdery fake-cheese filling.
Coming soon: pink wafers and Viennese fingers.
Hotel Chocolat – but only the official *Twilight: Breaking Dawn* selection box (WIRED is Team Pattinson, in case you're wondering).
Tiny monkeys playing pianos – as witnessed by our editor during a tour of MIT's laboratories. Sadly, not tiny enough for his hand luggage.

Office additions:
This month we are joined by tablet designer Claire Cheung.
Welcome to the team, and thanks for the chocolate.

Rejected this month:
"Baked beans" (replaced with "minestrone", because it's considered to be more aspirational).

Extra credit:
WIRED 100 [p98]: photographer's assistant: Kat Green; photo lab: HammerLab (hammerlab.co.uk); image retouchers: Sam Twiddy and Lee Hickman.
Lily Cole [p35]: hair stylist: Johnnie Sapong; make-up artist: Martina Luisetti; stylist: Alexandria Reid; clothing: top by Acne, skirt by Proenza Schouler.

WIRED globetrotters:
Our features often travel further than our writers – take our David Karp story from 03.12, which was picked up by three of our sister publications. Can you spot the differences? *Clockwise from right*: Japan; Germany, Italy.

Sources for the WIRED index:
[p23] top500.org/lists/2010/11
[p27] mitsui.com/jp/en/business/challenge/1191100_1856.html
[p31] pres-outlook.com/infocus-features/current-features/16302-pew-study-shows-christianity-counts-as-truly-a-global-faith.html

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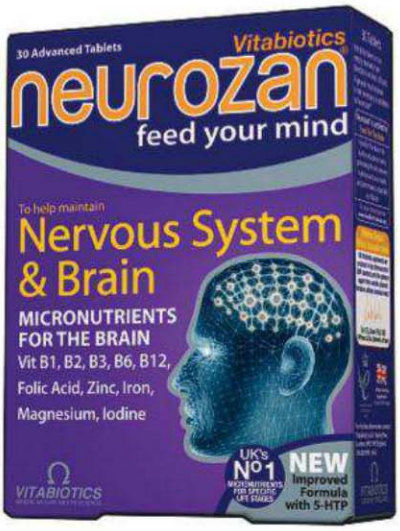
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Brands from the future

026: Mouse-B-Gone Mice are unwelcome guests – but with a little drug-induced "persuasion", they can be convinced to visit the great cheese factory in the sky. If it's self-inflicted, it can't possibly be cruel.

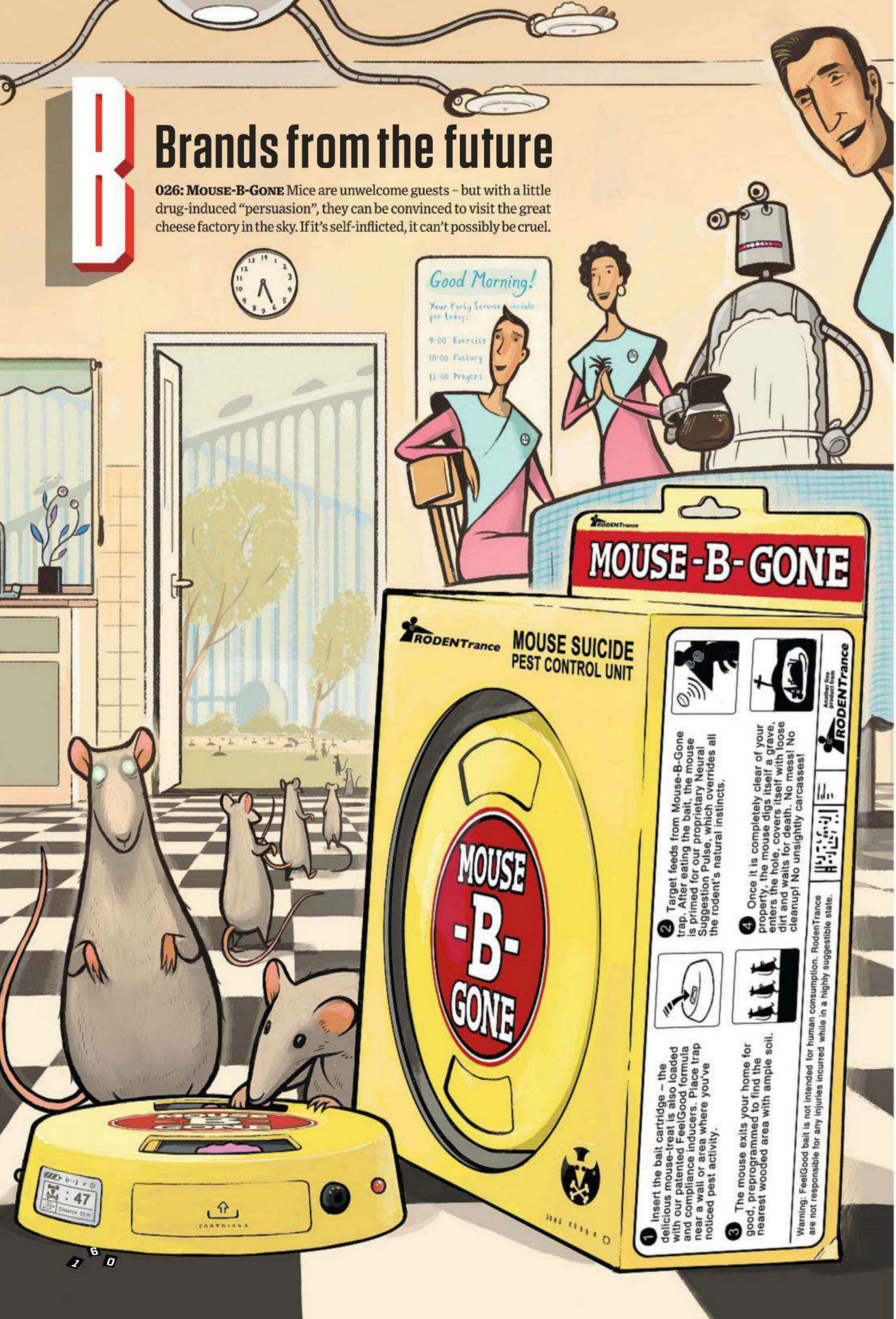
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ILLUSTRATION: STEPHEN COLLINS. Have you seen a brand from the future? Share your vision of tomorrow at *editorial@wired.co.uk*

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